

Glacier National Park

Spring and Fall

Teacher's Guide

Table of Contents	Page #
Dear Teacher and Glacier Education Goals	4
Background Information	5 - 27
National Park Mission & Glacier Significance	5
Geology	7-11
Climate Change	11-16
Plants/Forests	17-21
Fire	21-24
Animals	24-26
Native Americans	26-27
Activities and Lessons	28-73
Create A National Park	28
Locating Glacier National Park	30
What is Wild?	35
Surviving in the Wild	37
Who Eats Who?	43
Visual Vocabulary	48
What's that Habitat?	49
Beaver Succession Mural	50
Tree Parts	52
Old Growth Forest Mural	54
Eco-Enrichers	55
Forest Poems	57
Meet A Tree	59
Meeting the Fire Triangle	60-65
Predicting the Future	67
Puzzle it out	69
Carbon Cycle Capers	71
Poster Campaign	73
Supplementary Materials	74-101
Coloring book Pictures	74
Bird Checklist for Glacier National Park	83
Mammals Checklist for Glacier National Park	87
Vocabulary	89
Resources and References	100

Acknowledgements

Thanks to all of the Glacier National Park Education Rangers and Interpretive Staff for help with this guide. It is a work in progress. Please direct corrections, comments, or additions to Laura Law, 888-5837, laura_law@nps.gov. Cover artwork is by Robin Peterson and is available as a color poster through the Glacier Natural History Association, 406-888-5756.

Dear Teacher,

A spring field trip to Glacier National Park offers unique opportunities for studying and experiencing plant and animal life as it transitions from winter.

One of the reasons that Glacier National Park was established in 1910 was to protect habitat for plants and animals and to preserve natural processes. Glacier provides an undisturbed location to observe interrelationships in nature. Glacier Staff have been leading hikes for students and their teachers for over 20 years. This guide is divided into three sections: 1) Background information about Glacier natural and cultural resources 2) Pre- and post-visit lesson plans; 3) Supplementary materials. Our website at www.nps.gov/glac/forteachers/ contains many more lesson plans, coloring book drawings, and background information pages for all of our field trips. This guide contains just a sample of what is available.

Please verify the confirmation letter dates for your field trip and meeting place. A fee waiver for the park entrance fee has been processed for your group so there is no cost for the field trip. The education ranger assigned to your group will be calling you before your field trip date to discuss the schedule and answer any questions you may have.

Thank you for introducing your students to the National Park Mission and the wonders of Glacier.

*Glacier National Park
Education Staff*

Glacier National Park's Education Goals:

- To provide opportunities for the students to form their own emotional and intellectual connections between park resources and values.
 - To introduce students to the mission of the National Park Service and the significance of Glacier National Park.
 - To provide a curriculum-based, outdoor education experience that is age appropriate and supplements classroom learning objectives.
 - To introduce students to the value of protecting natural and cultural resources for future generations.
-



NATIONAL PARKS

What is a national park? National parks are federal areas designated by the United States Congress or the President, as places to be preserved and protected because of their importance to our nation. The National Park Service Mission states that these places will also “provide” for the enjoyment of the people of our nation. The National Park Service Website has information on all of the National Park Units in the U.S. as well as games and activities for students to become “Web Rangers.” Go to <http://www.nps.gov>.

GLACIER’S PURPOSE

- Preserve and protect natural and cultural resources unimpaired for future generations (1910 legislation establishing Glacier National Park; 1916 Organic Act).
- Provide opportunities to experience, understand, appreciate, and enjoy Glacier National Park consistent with the preservation of resources “in a state of nature” (1910 legislation establishing Glacier National Park; 1916 Organic Act).
- Celebrate the ongoing peace, friendship, and goodwill among nations, recognizing the need for cooperation in a world of shared resources (1932 international peace park legislation).

GLACIER’S SIGNIFICANCE

- Glacier’s scenery dramatically illustrates an exceptionally long geologic history and the many physical processes associated with mountain building and glaciation.
- Glacier has the finest assemblage of ice age alpine glacial features in the contiguous 48 states, and it has relatively accessible, small-scale active glaciers.
- Glacier provides an opportunity to see evidence of one of the largest and most visible overthrust faults in North America, exposing well-preserved Precambrian sedimentary rock formations.
- Glacier is at an apex of the continent and one of the few places in the world that has a triple divide. Water flows to the Atlantic, Pacific and Hudson Bay.
- Glacier offers relatively accessible spectacular scenery and increasingly rare primitive wilderness experiences.
- The Going-to-the-Sun Road, one of the most scenic roads in North America, is a National Historic Landmark.
- Glacier’s backcountry offers a challenging, primitive wilderness experience.
- Glacier is at the core of the Crown of the Continent ecosystem, one of the most ecologically intact areas remaining in the temperate regions of the world.
- Due to wide variations in elevation, climate, and soil, five distinct vegetation zones overlap in Glacier and have produced strikingly diverse habitats that sustain plant and animal populations, including threatened and endangered, rare, and sensitive species.
- Glacier is one of the few places in the contiguous 48 states that continue to support natural populations of all indigenous carnivores and most of their prey species.
- Glacier provides an outstanding opportunity for ecological management and research in one of the largest areas where natural processes predominate. As a result, the park has been designated as a Biosphere Reserve and Waterton-Glacier International Peace Park has been designated as a World Heritage Site.

- Glacier's cultural resources chronicle the human activities (prehistoric people, American Indians, early explorers, railroad development, and modern use) that show that people have long placed high value on the area.
- American Indians had a strong spiritual connection with the area long before its designation as a national park. From prehistoric times to the present, American Indians have identified places in the area as important to their heritage.
- The park's roads, chalets, and hotels symbolize early 20th century Western park experiences. These historic structures are still in use today.
- The majestic landscape has a spiritual value for all human beings – a place to nurture, replenish and restore themselves.
- Waterton-Glacier is the world's first International Peace Park.
- People of the world can be inspired by the cooperative management of natural and cultural resources that is shared by Canada and the United States.
- Glacier National Park and Waterton Lakes National Park offer an opportunity for both countries to cooperate peacefully to resolve controversial natural resource issues that transcend international boundaries.

GLACIER HISTORY

- Archaeological evidence within the park demonstrates early people use of area to over 10,000 years ago.
 - By 1780s, the South Piikani (or Piegan) – the Blackfeet – dominate the plains east of Glacier, basing their livelihood on hunting bison on the plains supplemented with the resources of the mountains and foothills.
 - The Kootenai were probably the most frequent visitors from the west; others were the Salish and the Kalispel.
 - 1810 – Finian MacDonald and two French-Canadians were first recorded white men to enter area of present-day Glacier National Park – to cross mountains, fight Blackfeet and hunt buffalo on the plains, along with about 150 Indians from the west.
 - 1817 – Fur trader Hugh Monroe, possibly first white man acquainted with the Blackfeet.
 - 1880s-1902 – mining attempts produced little and abandoned within a few years.
 - 1890s – early Glacier explorer George Bird Grinnell and others pushed for establishment of a national park to protect the area.
 - 1895 – East half of Glacier was purchased from the Blackfeet by the federal government.
 - 1900 – Area was made a Forest Preserve but was open to mining and homesteading.
 - Grinnell and others continued to push for more protection and were rewarded on May 11, 1910, when President Taft signed the bill establishing Glacier as the country's 10th national park.
 - 1910 – August, William R. Logan appointed first "Superintendent of Road & Trail Construction" – but had to deal with massive forest fires.
 - May 2, 1932 – Waterton Lakes and Glacier National Parks were designated as the world's first International Peace Park.
 - Fall 1932 – Going-to-the-Sun Road (50 miles long) was finished across Logan Pass. (Earliest opening – May 16, 1987; Latest opening – June 23, 1991 & 1995; Earliest closing – October 4, 1990; Latest closing – November 21, 1952)
 - Acreage: 1,013,572.42 acres (410,496.8 ha)
-

- Square miles: 1,600 (4144 sq.km)
- The largest lake is Lake McDonald: 10 miles (16 km) long, 1-1½ miles (2.4 km) wide, 472 feet (144 m) deep.
- Has Triple Divide – water flows to three drainages: W to the Pacific, SE to the Gulf of Mexico, and E and NE to the Hudson Bay.
- Highest elevation: Mt. Cleveland 10,466 ft. (3192 m).
- Lowest elevation: junction of Middle and North Forks of the Flathead River, 3150 ft. (960 m).
- 1976 – Glacier National Park is designated a Biosphere Reserve by UNESCO (United Nations Educational, Scientific and Cultural Organization).
- 1995 Waterton-Glacier International Peace Park is designated a World Heritage Site.
- 1997 – Going-to-the-Sun Road designated a National Historic Landmark.
- Visitation: 1,686,007 (1999)

SPECIAL DESIGNATIONS

- 1895 54-square-mile (140 sq.-km) area declared Kootenay Lakes Forest Park, later renamed Waterton Lakes Dominion [National] Park.
- 1910 Establishment of Glacier National Park.
- 1932 Creation of Waterton-Glacier International Peace Park.
- 1976 Glacier National Park designated a Biosphere Reserve.
- 1979 Waterton Lakes NP declared the second Canadian Biosphere Reserve.
- 1995 Waterton-Glacier International Peace Park declared a World Heritage Site.

GEOLOGY

The Setting

Over 1800 square miles (4660 sq. km) of the rugged Rocky Mountains are found within the boundaries of Waterton-Glacier International Peace Park. Two mountain ranges, the Livingston and the more easterly Lewis Range trend from northwest to southeast through Glacier. The Continental Divide follows the crest of the Lewis Range. Elevation varies from a low of 3150 feet (960 m) at the junction of the Middle and North Forks of the Flathead River (near the Lake McDonald valley) to a high of 10,466 feet (3192 m) on Mt. Cleveland. There are 6 peaks over 10,000 feet (3050 m) and 32 peaks over 9100 feet (2770 m) found in Glacier National Park. The impressive mountains and valleys within the park are the result of approximately 1.6 billion years of earth history and a number of geologic processes, including, erosion, sediment deposition, uplift and thrust faulting and glaciation. Waterton-Glacier is a geologic park. The geologic processes happened in three stages:

1. The sedimentation or deposition of the rock;
2. The uplift of the mountains; and
3. The glaciation or carving out of mountain valleys.

Waterton-Glacier has some of the oldest and best preserved sedimentary rocks found anywhere in North



America. Usually, over time and with heat and pressure, sedimentary rock becomes metamorphic rock. For example, limestone becomes marble. It is quite unusual that this old rock still retains its sedimentary characteristics.

Ancient Sediments – 1.6 billion to 800 million years ago

The majority of the rocks forming the mountains of the Peace Park are the result of the deposition of sediments into an ancient inland sea that existed over 1600 million years ago during the middle Proterozoic Era. The ancient Belt Sea covered parts of present-day eastern Washington, northern Idaho, western Montana, and nearby areas in Canada. During the period of active deposition over 18,000 feet (5500 m) of sediment eroded from nearby highlands and were carried into the sea. Accumulation of sediment subsequently resulted in down-warping of the sea floor. Also, over time and as environmental conditions varied, a variety of different materials were eroded and washed into the Belt Sea. The result was alternating layers of sediments of differing composition. With time, and as the sediments accumulated, the heat and pressure created layers of quartzite, siltite, argillite, limestone, and dolomite. The sedimentary character of the rocks in Waterton-Glacier is clearly evident in the form of preserved mud-cracks, ripples, and layers; the crystal structure of each formation has been slightly metamorphosed, creating what can accurately be called metasedimentary rock. The combined rock formations that occur in Waterton-Glacier are part of the Precambrian Belt Supergroup and are readily visible in the 33 percent of the park above treeline. Because of the age of these rock structures, no developed life forms are found as fossilized remains; instead only fossilized algae beds have been found.

Stromatolites – a fossil algae colony dating from the Belt Sea

Six species of blue-green algae that thrived in shallow parts of the Belt Sea played a significant role in the formation of the carbonate rocks of the park. They are mostly found in the Altyn and Helena (Siyeh) Formations. Stromatolites have shapes and internal structures very similar to blue-green algae that live in present-day seas less than 100 feet (30 m) deep. Sunlight allows algae to consume carbon dioxide from seawater and release oxygen in the process. There are two important results from this process:

1. When algae remove carbon dioxide from the seawater, fine particles of calcium carbonate are formed from a chemical reaction. The sticky ooze secreted by the algae also traps fine sediment precipitated from the seawater. Removal of carbon dioxide from seawater caused the formation of large quantities of calcium carbonate, which contributed to the great thickness of carbonate rocks in the park.
2. Oxygen is released into the atmosphere. This was a major factor in producing the oxygen-rich atmosphere that allowed development of oxygen-consuming life forms on earth.

An Intrusion of Magma - 750 million years ago

While most of the rock in the Peace Park is metasedimentary in nature, late in the Proterozoic some igneous rock in the form of lava flowed onto the sea floor. Additional igneous material was intruded between layers of limestone forming sills at an even later time. Today the igneous materials are evident as pillow lava formations (black basalt) in the Granite Park area (granite does not occur in the park) and as the Purcell Sill that runs through the Siyeh Limestone, a dark band of igneous rock (diorite) about 100 feet (30 m) thick. The heat of the intrusion forced out the

dark organic matter from the surrounding limestone, recrystallizing it into white marble (metamorphic rock). The Purcell Sill is seen throughout the parks, for example on Mt. Siyeh and the north side of Mt. Cleveland in Glacier, and Mt. Blakiston near Red Rock Canyon in Waterton.

Lewis Thrust Fault – 60-70 million years ago

Approximately 150 million years ago, collision of crustal plates on what was then the western edge of North America resulted in the beginning of mountain building processes inland that would continue until about 60 million years ago. In the area that would become Waterton-Glacier International Peace Park, massive forces uplifted a slab of rock several miles thick, which slid east some 50 miles (80 km) over much younger rock. The Lewis Overthrust Fault is major evidence of the tectonic events that created the mountain scenes of present day Glacier and Waterton. However, numerous other events were occurring simultaneously; synclinal folding and other types of faulting are also evident in Waterton-Glacier. As a result of the uplift, erosive forces accelerated and over several million years removed the upper layers of material, exposing the rock formations evident in the park today.



Glaciation: The Ice Age – 2 million years ago

The geologic event that would define the landscape began with a global cooling trend approximately 2 million years ago. The Pleistocene Ice Age saw large ice sheets repeatedly advance and retreat throughout the temperate regions of North America until about 10,000 years ago. In the area that would become Waterton-Glacier International Peace Park, ice advanced and retreated until probably melting completely about 12,000 years ago. During the ice advances, the lower valleys were filled with glaciers and only the very tops of the higher peaks were visible. The “rivers of ice” sculpted the mountains and valleys into a variety of landforms associated with major alpine and valley glacial action. Even though the Ice Age glaciers

are gone, the results of their passing are evident on the landscape. Massive U-shaped valleys, numerous cirque lakes or tarns, horns, cols, moraines, and aretes are but a few of the glacially carved landforms that contribute to the beauty of Waterton-Glacier International Peace Park.

Recent Glaciation – dating from about 6,000 years ago

Today, we are living in a relatively warm interglacial period. All remnants of the Pleistocene ice have disappeared. There are no active glaciers in Waterton Lakes National Park; however, the last survey in Glacier NP resulted in 27 named alpine glaciers. They are of relatively recent origin, having formed in the last 6,000 to 8,000 years. They probably grew rapidly during the Little Ice Age that started about 400-500 years ago and ended about 1850. However, they work in the same way as larger glaciers of the past.

A glacier forms when more snow falls each winter than melts the next summer. With alternating freezing and thawing, the snow becomes granular ice. As these layers build up, the ice recrystallizes, becomes denser, and eventually forms a massive sheet. The ice needs to be about 100 feet (30 m) thick for a glacier to form and have a surface area of at least 25 acres. (10 ha). Ice near the surface of the glacier is often hard and brittle. Due to the pressure of ice above, the ice near

the bottom of the glacier becomes flexible. This flexible layer allows the ice to move. Depending on the amount of ice, the angle of the mountainside, and the pull of gravity, the ice may start to move downhill. Once the ice begins to move, it is called a glacier. As the ice moves, it plucks rock from the sides and bottom of the valleys. Rocks falling on the glacier from above mix with the glacial ice as well. Over long periods of time the sandpaper-like quality of the moving ice and rock scours and reshapes the land into broad U-shaped valleys, sharp peaks, and lake-filled basins.

Tree-ring studies indicate that retreat of the recent glaciation began about 1850. When Glacier National Park was established in 1910, there were more than 150 glaciers within the national park compared to about one fourth of that number now. Retreat rates appear to have been slow until about 1910. There was a period of rapid retreat during the mid- to late 1920s. This corresponds to a period of warmer summer temperatures and decreased precipitation in this region. Several of the larger glaciers separated into two smaller glaciers at this time. The Jackson and Blackfoot Glaciers separated as did the Grinnell and Salamander Glaciers. If the current rate of recession continues, it is estimated that there won't be any glaciers in Glacier National Park by 2030.

What sets our mountains apart?

- There is a relatively flat lying Lewis Thrust sheet from which our mountains formed. The mountains of Waterton-Glacier are a result of one major fault and many minor ones, instead of many major and minor faults often found in mountain ranges, such as the front ranges of Banff and Jasper National Parks in Alberta. The fault extends from south of Marias Pass north 348 miles (560 km) to Banff NP, thrust in a northeasterly direction and coming to rest after millions of years. Most of the horizontal displacement occurred in the Waterton-Glacier area.
- The ancient rocks of the Belt Sea that form our mountains have much less limestone (limestone is mainly a by-product of sea life) and fewer fossils than the younger rock exposed in most of the Rockies.
- The Lewis Thrust sheet was displaced about 50 miles (80 km), as opposed to thrust sheets in the rest of the Rockies that were displaced over much shorter distances.
- The varied colors of the rock in the mountains, including the reds, greens and maroons are the result of small amounts of various iron minerals.
- There is an abrupt transition of mountains and prairie. Although the disturbed subsurface rock structures typical of foothills are present here, they are covered by glacial debris.
- Here is the oldest exposed sedimentary rock in the entire Rocky Mountain chain – 1.6 billion years old.

The Continental Divide

The Continental Divide separates the Atlantic and Pacific watersheds of North America. In Glacier, the divide follows the crest of the Lewis Range from Marias Pass to Flattop Mountain and then swings west to the crest of the Livingston Range, which it follows into Canada. The Continental Divide forms the western border of Waterton Lakes National Park, which lies completely on the east side of the divide. In Waterton, all drainages flow into the Saskatchewan River Basin, generally a northeast route towards Hudson Bay.

Triple Divide

In Glacier National Park, there is actually a triple divide because waters potentially can flow into three oceans. The creeks and streams in the southeast section of the park feed into the Birch and Marias Rivers, then the Missouri and the Mississippi and empty into the Gulf of Mexico. The water in the northeast section feeds into the St. Mary River that joins the Saskatchewan River Basin. From there, some of the water flows into Lake Winnipeg, then into the Nelson River which drains into the Hudson Bay. All water west of the divide feeds into the Flathead River, which then flows through Flathead Lake and empties into the Clark Fork which joins the Columbia River to the Pacific. The many streams of Waterton-Glacier make important contributions to the great rivers of the continent. There are few other areas of similar size that generate a volume of water equal to that flowing out of the parks. Glacier's Triple Divide Peak (8020 ft/2446 m) is a rather rare hydrologic feature. From the summit, water flows to the Atlantic Ocean, the Pacific Ocean, and Hudson Bay. The peak can be viewed from the Going-to-the-Sun Road in the Two Dog Flats area, on the east side of the park. Other triple divides (hydrological apexes) are found in Jasper National Park and in Siberia.



CLIMATE CHANGE

Climate and the Greenhouse Effect

The earth's climate system is a complex and dynamic tapestry woven of physical processes and many individual components. These components may be gaseous (atmosphere), fluid (oceans, or solid (land, ice and snow, terrestrial, and marine life forms) and they may interact with each other on many different time scales (20,000 years for a sheet of ice to sculpt a mountain range or 1 week for a hurricane to cruise up the East Coast). One of the key components of earth's climate system is the Greenhouse Effect- the thermostat.

Life on earth exists because temperatures favored the creative process. Interestingly enough, these favorable temperatures have been perpetuated by... life on earth. The planet is warmed by sunlight and radiates the resultant heat in the form of infrared energy. If all of this radiated heat were to escape into space, the planet's temperature would be too cold to support life. Luckily, some of the radiated heat is trapped in the atmosphere by the gas carbon dioxide (and other gases: water vapor, methane, halocarbons, ozone, and nitrous oxide). This trapped heat warms the planet's surface, allowing life forms to thrive and grow- hence the name "greenhouse."

Life on Earth is described as carbon based - utilizing carbon as the central element in its molecular structure. Carbon is fixed or stored in living tissue during the growth process and it is released into the atmosphere during the process of decomposition. When the planet grows too cool, more living forms die, decompose, and release carbon dioxide into the atmosphere. This in turn increases infrared energy absorption which then raises the temperature of the planet and promotes the growth of life forms. So the temperature of the planet is continually fluctuating up and down within a favorable range and at a rate that is determined by the growth and decom-

position cycles of the life forms. This very neat system for regulating Earth's temperature works relatively smoothly as long as the parameters of the equation remain the same. They haven't.

Rising concentrations of CO₂ and other green house gases are intensifying Earth's natural green house effect. The concentration of CO₂ has risen about 30% since the late 1800's. The concentration of CO₂ is now higher than it has been in at least the last 400,000 years. This increase has resulted from the burning of coal, oil, and natural gas, and the destruction of forests around the world to provide space for agriculture and other human activities. As we add more CO₂ and other heat-trapping gases to the atmosphere, the world is becoming warmer.

The following information courtesy of Glacier's Crown of the Continent Research Learning Center

Climate Change and Biotic Patterns

A biologically diverse ecosystem, Glacier National Park is a highly heterogeneous landscape that is home to a rich diversity of plants and animals. One reason for this is the steepness of the terrain. With high mountains and low valleys, dense forests and open meadows, and numerous wetland habitats, Glacier can provide a home to an amazing array of species. But as climate changes, ecosystems will change too. Exactly how our current warming climate will affect Glacier's biotic communities is an active area of scientific research.

Climate helps determine what flora and fauna exist in a habitat. Every species has temperature and moisture ranges within which they can survive and thrive. Glacier's weather and climate can be highly variable from high to low elevations and also between the east and west sides of the Continental Divide. The cool, harsh high alpine environments support very different species than the milder conditions usually found at lower elevations. East of the divide tends to be colder and drier than west because the Pacific maritime climate delivers moisture and heat from west to east. The temperature range, amount of rain, wind, and other climatic conditions that each part of the park receives helps to define the kinds of organisms found there. While not static, these micro-climates create diversified and distinct communities within the landscape.

As climate changes, plants and animals adapted to current conditions and locations will either need to adapt to survive in different conditions or "follow" the temperature range in which they can survive. The ability of populations to adapt or move when climate changes depends on many factors, one which is the rate of change. The current warming climate is accelerated by human activities and it is unclear how, or even if, most modern species can adapt well enough to survive. In a warming climate, vegetation zones will tend to migrate northward and/or up-slope to higher elevations. Alpine treeline studies help scientists understand how this process takes place. Studies from Glacier suggest forest patches at high elevations are getting denser and are beginning to invade alpine meadows. Of major concern is the potential loss of alpine and sub-alpine environments that provide prime habitat for plants such as Jones Columbine and White Mountain Avens, animals like bighorn sheep and mountain goats, and winter hibernation space for bears. Species living here cannot migrate to higher ground.

While some species may be able to move and adapt to climate change, the current rapid rate of

warming may present significant difficulties for others. Some vegetative communities, such as old growth forests, are not capable of migrating quickly. In other cases, migration may not occur due to lack of suitable corridors that connect current locations to higher or more northern territories where the plants can become established and thrive. Roads, urban and industrial areas, and agricultural fields all present obstacles to the migration potential of plants and animals. Species that cannot adapt or move, will not survive.



Changes In Disturbance Regimes

Climate change will effect not only the types of plants and animals that can survive in certain areas, it will also impact processes that shape the landscape such as fire. For example, changes to temperature and precipitation patterns will effect soil moisture as well as the frequency of storms (which bring lightening that start fires). In general, under warming conditions, scientists expect there to be a greater potential for more frequent, larger, more severe, and more intense wildland fires. While fire is an important shaper of Glacier's landscape, too intense or too frequent fires may make it more difficult for native species to return. Disturbance by fire may create an ideal environment for non-native, invasive species to thrive.

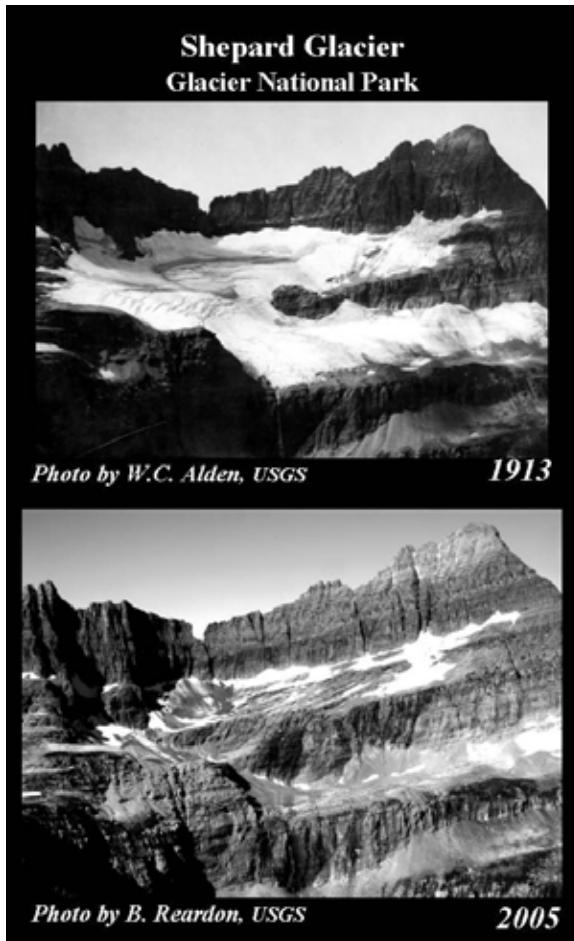
Global Climate Change and Melting Glaciers

Global warming is one of the most pressing environmental issues of the 21st century. For many years, scientists have been studying this phenomenon and the evidence is now clear. Earth's climate is warming and mountain ecosystems like those found in Glacier National Park are seeing some of the most dramatic changes. In the last 100 years, global average temperature increased by 1.6 degrees Fahrenheit with accelerated warming over the last two to three decades. The 1990s were the hottest decade, not just of the last century, but of the last millennium! The 5 hottest years of record since the 1890s, in rank order, were 2005, 1998, 2002, 2003, and 2004. Scientists predict that by the end of the 21st century Earth will experience a warming trend of 2-10 degrees. While this may not seem like much, it could bring major changes to Earth's ecosystems, especially those at high altitudes and latitudes like Glacier National Park.

While Earth's climate is known to have changed in the past due to natural causes, the warming trend over the last few decades is primarily the result of human activities. Of major concern is the buildup of carbon dioxide and other "greenhouse gases" in the atmosphere. Greenhouse gases hold heat in the atmosphere that would otherwise radiate back out into space. While the greenhouse effect is what has made life on Earth possible, these gases are now increasing at an alarming rate. Since the beginning of the industrial revolution, the carbon dioxide concentration in the atmosphere has increased by 30%. Human activities that release carbon dioxide are burning of fossil fuels, harvesting and burning trees, and land conversion to cities and agriculture.

Melting Mountain Glaciers

Glaciers are formed when more snow falls in winter than melts in summer. As snow accumulates over many seasons it becomes ice. The weight from snow and ice causes the bottom layers



to move, fashioning a frozen river of snow and ice that slowly flows across the landscape, eroding and shaping it into unique landforms. When this process is reversed, the glaciers retreat back up the mountain. The advance and retreat of glaciers is strongly tied to temperature and precipitation and is a simple, but effective way to monitor climate change. The amazing mountains and valleys of Glacier National Park were sculpted by the action of glaciers over hundreds of thousands of years of glacial advance and retreat. In 1850, at the end of the Little Ice Age, there were an estimated 150 glaciers in the park. By 1968, these had been reduced to around 50, 37 of which had been named. Today the number of glaciers in the park is 27, many of which are mere remnants of what they once were.

Rapid retreat of mountain glaciers is not just happening in Glacier National Park, but is occurring worldwide. While Earth's climate has undergone cooling and warming cycles in the past, the rate and magnitude of change we are witnessing today has not occurred since human civilization began. If the current rate of warming persists, scientists predict the glaciers in Glacier National Park will be completely gone by the year 2030. The total loss of glaciers will

certainly be a major change for Glacier National Park. For many people, the glaciers are one of the reasons the park holds special significance and are a feature they expect to see when they visit. Glaciers are also an important natural resource, providing vital functions for the ecosystem.

Climate Change and the Water Cycle: Water Towers of the World

Glacier National Park is famous for its mountainous landscape and glacially carved terrain. What many people don't realize is that mountain glaciers provide more than just scenery. Glaciers are an integral part of the ecosystem, providing water to mountain and downstream environments. In today's warming climate, these giant marvels of snow and ice are rapidly disappearing.

Mountains have been called "water towers of the world." More than 50% of the world's fresh water supply comes from runoff in mountain environments. While much of the runoff from mountains comes from rain and melting snow, alpine glaciers are an important contributor to mountain stream flow. Globally, glacial meltwater provides one-fourth of the water in mountain streams. By providing a dependable source of cool, fresh water, glaciers are essential to the health of aquatic and riparian ecosystems. They also provide fresh drinking water for downstream populations and dilute pollutants that are generated mostly in lowland areas. As climate

warms and glaciers melt, these ecosystems are losing an important source of fresh water.

Glacier National Park has already lost more than 70% of its glaciers in the last century. Today there are 27 of the 150 glaciers that were recorded in 1850, the end of the period called the Little Ice Age. At the present rate of warming, scientists predict that all of the glaciers in Glacier Park will be gone by the year 2030. The demise of glaciers will affect both the amount and timing of mountain stream flow.

Stream Regulators

Mountain streams in Glacier National Park are fed by alpine glaciers and snowpack. In summer, once it becomes warm enough to melt the snowpack, a rush of water comes down the mountains from glaciers to join the streams and rivers. Then, for the rest of the warm season, mountain streams are augmented by a constant flow from melting glaciers. When rain is sparse, as in the late summer and during drought years, mountain glaciers may be the only source of base flow in some mountain streams.

As climate warms, this pattern is changing. With a warming climate, less winter precipitation falls as snow but more of it falls as rain. Also, spring comes earlier. The longer warm season will allow even more snow and ice to melt. Earlier, warmer summers mean spring runoff from mountains happens earlier in the year, and often in a bigger rush of water downstream. In the Pacific Northwest region, spring runoff is now happening up to two weeks earlier than it used to. A concern with global warming is the possibility of more spring floods due to the pulses of rain combined with melting snow and ice.

As mountain glaciers melt and spring runoff happens earlier, there is less water later in the season. For many small mountain streams, melting glaciers provide the only source of base flow in late summer. With no glacial meltwater to augment them, some streams may become ephemeral, drying up late in the season. This will have major consequences for stream ecology. In addition to regulating stream flow, glacial meltwater effects the temperature of mountain streams and rivers. Many of the invertebrates that live in Glacier National Park's waters are very temperature sensitive and can only live within a narrow temperature range. Because aquatic invertebrates are at the base of the food chain, putting them at risk threatens the entire stream ecosystem.

Glacier's Management Strategy

Climate change, especially the rapid change we are currently experiencing, is a serious issue. As scientists work to understand how Glacier's ecosystems will be impacted, managers struggle to understand what kinds of decisions can and should be made in the face of these changes to protect park resources. It is unlikely that any management actions would be sufficient to preserve Glacier National Park in its current state. Some level of change is inevitable and may even be desirable. Unfortunately, there is no simple solution. In some cases, managers may be forced to choose when and where to invest limited time and energy for resource protection and restoration. For example, areas such as old growth cedar-hemlock forests, that evolved in a much colder climate, may simply have to be understood as remnants of another time. In other cases, park managers may need to work with other agencies and land managers to identify and protect corridors that connect important wildlife habitats to allow species to migrate. Management

strategies for disturbances such as fire and invasive plants will need to adapt to the context of climate change pressures. Research and internal education efforts can help park staff become aware of the issues and can encourage discussions that may provide new ideas and approaches. Engaging the support of our neighbors and partners will be critical as we seek solutions to these complex issues.

Changes to the status of aquatic systems due to climate change is of great concern to Glacier Park managers. Park staff work closely with research scientists to monitor stream health. Healthy streams have been identified as a park “vital sign,” which means they are an important indicator of the overall integrity of Glacier’s ecosystems. Vital Signs monitoring is part a national program in the National Park Service to understand the state of natural resources and provide an early warning for park managers of changes in ecosystem health. Many natural resources in the National Park System are subjected to unfavorable impacts from a variety of sources, including climate change. Left unchecked, the very existence of many natural communities can be threatened. To help prevent the loss or impairment of such communities in approximately 270 parks nationwide, the NPS Inventory and Monitoring (I&M) Program was established as part of the Natural Resource Challenge in 1999.

The principal functions of the I&M Program are the gathering of information about the resources and the development of techniques for monitoring the ecological communities in the National Park System. Ultimately, the inventory and monitoring of natural resources are integrated with park planning, operation and maintenance, visitor protection, and interpretation to sustain the preservation and protection of these resources. The I&M Program is designed to help parks preserve healthy parks by acquiring timely and accurate information about the condition of natural resources and monitoring any changes over time so that managers can act on that information with confidence. Park employees monitor the health of aquatic environments. Many aquatic organisms are highly temperature sensitive. Warmer water and reduced stream flow later in the year could have very detrimental consequences for these systems.

Now that the impacts of global warming are beginning to be understood, managers are taking the issue very seriously. Ultimately, greenhouse gas emissions, especially carbon dioxide, must be reduced. The National Park Service, in partnership with the Environmental Protection Agency, held a workshop in Whitefish, MT for park personnel in December 2003 to discuss the issues relating to climate change in the park and what steps the park can take to respond to this threat. An assessment of greenhouse gas emissions from Glacier was conducted prior to the workshop to provide background what the primary activities are that can be targeted for emissions reduction. The single greatest contributor to carbon dioxide emissions in the park is transportation. Other significant sources are energy use in buildings and solid waste disposal. A number of the actions from the plan have already been taken to reduce greenhouse gas emissions and raise awareness of the issues. These include employee transportation alternatives like the Red Bike Program and bus and carpooling initiatives, as well as a recycling plan, and monitoring energy use in buildings. Visitor transportation options are also being planned in conjunction with the Going-to-the-Sun Road rehabilitation project.

GLACIER PLANTS

Glacier National Park is home to at least 1,132 species of vascular plants (those containing vessels that conduct water and nutrients). There are 20 different tree species, 93 woody shrubs or vines, 88 annual or biennial plant species, and 804 types of perennial herbs. Included in these numbers are 127 non-native species. Besides vascular plants, the park also has at least 855 species of mosses and lichens. There are likely more than 200 species of fungi, but this group has not been as well-studied. Sixty-seven vascular and 42 non-vascular plant species found in Glacier Park are listed as “sensitive” by the State of Montana.

Glacier Park has 30 species that are “endemic” to the region, those with ranges limited exclusively to the northern Rocky Mountains. All but one of these occur in cold, open areas characteristic of harsh, post-glacial environments. Many are relics of the post-glacial age or occur here because the diverse combination of environmental conditions create unique micro-habitats. Three major North American watersheds arise from Glacier National Park (Arctic, Atlantic and Pacific). Two climate zones (Pacific Maritime and Prairie/Arctic) are separated by the Continental Divide. Biomes range from the lower elevation Pacific cedar-hemlock forest to the high alpine tundra. These life zones, separated along an altitudinal gradient, contain a range of biodiversity unmatched in the Northern Rockies.

Plant species in Glacier Park have affinities with four major floristic provinces: (1) Cordilleran [49%], including the southern and central Rocky Mountains as well as the Cascade Mountains of the Pacific Northwest; (2) Boreal [39%], similar to what one would find across Canada; (3) Arctic-Alpine [10%]; and (4) a few representatives from the Great Plains [1%].

Moist, temperate conditions on the west side of Glacier Park have allowed the eastern-most extension of Pacific cedar-hemlock forest to develop in the Lake McDonald Valley. Moisture from the Pacific coast condenses during its rise to the Continental Divide. Rainfall ranges from an average of 23 inches in the park’s driest locations along the northeast and northwest edges of the park to 30 inches at West Glacier. Precipitation in excess of 100 inches may fall in isolated cirques near the Continental Divide.

On the east side of the Park, dry chinook winds sculpt trees along the high ridges while calmer conditions prevail in the aspen groves below. The difference in rainfall is not extreme, but the desiccating winds have made the plant communities very different on the east side. The dark, ancient cedar/hemlock forests of the west side are a stark contrast to the more open forests, glades and grasslands of the east side. Plant varieties change somewhat north to south as well because the north half of the Park is in the rainshadow of the Whitefish Range. The cedar-hemlocks give way to drier Douglas fir and lodgepole pine forests in the North Fork, Flathead River drainage.

The Park’s plant cover is roughly 33% moist coniferous forest, 29% barren or sparsely vegetated rock/snow/ice, 16% dry coniferous forest, 8% dry meadow and prairie, 6% deciduous forest (primarily aspen and black cottonwood), 5% wet meadow or fen, and 3% lake surface water (with aquatic plants occurring in the shallower zones).

LIFE ZONES (HABITATS)

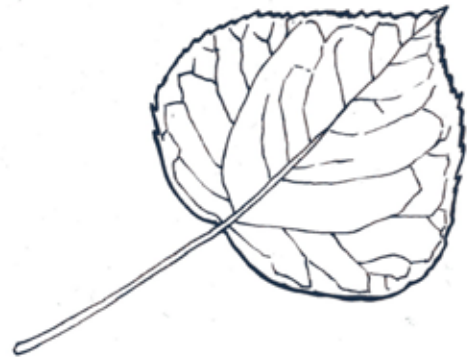
Grasslands

Also known as bunchgrass prairie, this grass association stretches in a narrow band from southern Alberta into Montana. In Glacier, the fescue grasslands are found on the southern slopes and valley bottoms of major drainages on the east side of the mountains. Due to the close relationship of the mountains with the grasslands, in some places prairie species have been found above tree limit in association with alpine species. Grasslands west of the divide exist as prairies nestled in the North Fork Valley. Historically, a short natural fire interval has swept through that valley, preserving native prairie species. More than a hundred species of grasses thrive in the drier, windblown areas of the park. Waterton Lakes National Park contains a 13-square-mile (34-sq.-km) area of prairie that is one of only two preserved within the Canadian national park system. [Note: Parks Canada information on life zones, or ecoregions, lists four and does not include grasslands as a separate zone. Their lowest classified zone is the Foothills Parkland Ecoregion “with its associated grasslands and aspen forests.” In this discussion that zone is listed next as the Aspen Parkland.]

Aspen Parkland

This zone consists of a broad band of forest and groves, which stretches across parts of three Canadian provinces and south into Montana. This region serves as a transition belt between the grasslands and the coniferous forest zone. The dominant tree cover is quaking aspen along with black cottonwood. Aspen forests are common in the eastern half of Waterton Lakes but are primarily restricted to valley bottoms in Glacier National Park. Shrub wetlands and marsh habitats are common constituents of this region. The aspen parkland is the most important winter range for elk and deer.

Ten percent of Waterton’s area is composed of foothills fescue-oatgrass-aspen parkland. Unlike cultivated grasses, native fescues retain much of their nutrient value through the winter. This is crucial for the large herds of elk wintering in the park. Frequent chinook winds also benefit ungulates, as the winds sweep snow from grassy areas. Winds also cause snow drifts on the lee side of hills and in sheltered gullies, creating a distributions pattern of trees and shrubs, shelterbelts for animals during windy winter days.

**Montane Forest**

This zone occurs at low to mid-elevations in both parks but on the eastern slopes is largely restricted to the dry foothills and major river valleys. It is a mix of dry grasslands and relatively open mixed poplar and coniferous forests. Douglas fir, white spruce, and limber pine are distinctive trees of this zone. Lodgepole pine is found but is not a good indicator species as it extends up into the Subalpine. In areas of greater moisture west of the divide in Glacier, cedar-hemlock forest is at the eastern edge of its range. On drier sites with higher fire frequencies, ponderosa pines predominate. Shrubs associated with the Montane are bearberry and juniper. Twinflower, thimbleberry, and meadow rue grow on the forest floor.

Alpine Tundra

The word “tundra” comes from the Finnish tunturi meaning “a treeless plain.” Treeline occurs at about 6,900 feet (2100 m) on the west slope and 6000 feet (1800 m) on the east side. The alpine zone above that covers nearly one-quarter of Glacier and Waterton. This is the land above the trees. Expanses of bare rock make up much of this zone. The high country is a land of harsh conditions. Winds are often strong. The sun is intense, 5 percent brighter than at sea level with increased ultraviolet radiation. Plant leaves are often covered by tiny hairs, as an adaptation to diffuse light and prevent burning. Though there is ample rainfall, the winds neutralize much of it. Summers are short, temperatures low, soils shallow.

There is a profusion of miniature plants, a universal adaptation. Short stature protects life from the most whipping winds. It means less exposed surface, cutting evaporation. It spares energy that might be used for growing tall stalks and broad leaves and puts the energy into essentials: production by seed or vegetatively (through rhizomes, bulbs, tubers). Most plants are perennial and grow in cushions, mats, and low clumps. Many alpine plants cope with the short growing season by developing in stages: stems and leaves one year, buds the next, blossoms, and seeds the third year. In Waterton-Glacier, cushion plant communities, alpine meadows, and alpine bog areas are common. A number of mammals including the pika, marmot, and mountain goat have also adapted to this harshest of environments.

Subalpine Zone

With increased elevation, the dense forest zone gives way to widely-spaced islands of dwarfed trees and lush meadows. The subalpine forest is the single most extensive vegetation community in both Waterton and Glacier. It is a region characterized by heavy snowfall and a short growing season. A boreal element is present with dwarf birch and fireweed.

In Waterton, at around 5000 – 6000 feet (1500-1800 m), the lower subalpine is a dense forest of spruce and fir characterized by heavy snowpack. In the upper subalpine, firs provide shelter for each other against battering winds and frigid temperatures. Wind and ice can shear off the growing buds of a tree so that the branches only grow on the leeward side; this is called flagging, as the trees resemble flags unfurled. Trees often form krummholz vegetation, growing stunted and twisted on exposed slopes.

Whitebark pine can grow in the harshest of sites, creating a microhabitat suitable for subalpine fir, thus extending the elevation of treeline. The park’s whitebark pine populations have nearly been decimated by white pine blister rust which was introduced from Europe in 1910. Other species include Englemann spruce and lodgepole pine.

Subalpine meadows are key habitat for bighorn sheep and seasonally for bears. The elusive wolverine inhabits this zone. Marmots, chipmunks and ground squirrels are commonly seen during summer months. Logan Pass is a good example of a well-traveled subalpine area.

Natural Processes and Baseline Studies

The components of local plant communities constantly change over time. Short-term natural disturbances (fires, avalanches, floods, windstorms) and long-term shifts in environmental

conditions (climate, glaciation) continue to cause change. All parks have already been modified to some extent by human activities. A major challenge for ecosystem researchers and managers will be to distinguish between natural changes and human-caused changes. Waterton-Glacier is unique in that, although there is human influence here, the area is relatively pristine and therefore offers a benchmark for baseline studies of such things as air quality, water quality, and wildlife in a relatively uncontrolled environment.

THE FOREST COMMUNITY

A forest is organized in vertical layers. The top layer is the canopy, or roof of the forest community. Here leaves catch the sunlight necessary for trees to create food, release oxygen, and provide shelter and shade in the forest below. Below the canopy are the understory trees; young trees of the canopy species, and smaller, shade tolerant trees that will never become part of the canopy. In the old growth forest the students will be visiting in W-GIPP, western red cedar forms the canopy, while western hemlock and Rocky Mountain maples form the understory.

Beneath the understory is the shrub layer, where knee-high to head-high woody plants reside. Beneath the shrub layer is the herb layer where ferns, grasses, wildflowers, and smaller woody plants grow. Here bunchberry dogwood, bracken fern and queencup are found, among others.

The forest floor is the bottom layer of mosses, mushrooms, creeping plants and forest litter (leaves, needles, twigs, feathers, bark bits, animal droppings, etc.). This is where decomposition occurs and where 95% of all insects live at some point in their life cycle. The final layer is the forest's basement, laced with plant roots, mycelia of fungi (the threads which nourish the mushroom), and tunnels of animals such as the ground squirrel and shrew.

Each layer of the forest has its characteristic animal species, although most feed in more than one level and some nest in one story and feed in another. Every animal and plant consumes a portion of the available nutrients and has its place in the forest community food chain, directly or indirectly affecting all the other organisms.

Old Growth Forest in Glacier

What is an Old Growth Forest?

Old growth forests are ecosystems dominated by large trees at least 250 years old, and have all of the following characteristics present at the same time:

1. Large living trees and a multi-layered canopy. The canopy is the leaf and branch layer of tall trees that form a roof over the forest community. In an old growth forest, the larger trees, two hundred feet tall or more, tower over the younger trees. Both grow together in a mixture of species. The uneven canopy is efficient at trapping moisture during the drier seasons. The huge trunks often survive fires, for they are reservoirs holding thousands of gallons of water and are protected by thick bark.
 2. Large standing snags. Snags are standing dead trees from which the leaves and most of the branches have fallen. Snags may stay erect for over two hundred years. As their branches fall off,
-



sunlight is able to reach the forest floor, allowing species that require light to take root. Insects and woodpeckers open up the dead wood, providing habitat for many other species, which in turn become food for larger predators.

3. Large down trees. Fallen trees help to hold soil in place, and as they decay over a period of two to five hundred years, many species of insects, birds and mammals use them for food and shelter. This activity helps raise the concentrations of nutrients like phosphorus and nitrogen in the rotting wood, which the rootlets of other plants can tap for food. Like live trees, fallen trees can hold large amounts of water.

4. Large fallen trees in streams. Fallen trees crisscross small head-water streams. The run off is not strong enough to move them and they become temporary “stairsteps” that hold woody debris long enough for 70 percent of it to be processed by insects and bacteria. Fish consume these insects and rely on the pool-forming ability of the forest for shelter from run-off and for temperature control.

Any one of these characteristics may occur in younger forests, but only in old growth forests do all four occur. The old growth forest the students will be visiting is a western red cedar, western-hemlock forest.

FIRE

Fire is a powerful force of nature. Ignited by lightning or by humans, fires fascinate and frighten us. When conditions are dry and windy a wildland fire can race through a forest, cross meadows and jump rivers. Or it can simply creep along in the undergrowth. Humans have used fire and tried to control it from the earliest times. While burned trees may look stark and dead, they are evidence of a natural process that helps maintain a healthy forest. In many ecosystems fire is essential for the continued survival of both the plants and animals that live there. While loss of homes, property or human life is a tragedy to be avoided, fire is a beneficial force necessary to ensure forest succession.

The summer of 2003 was the most significant fire season in the history of Glacier National Park. After a normal winter snowpack, precipitation was below average from April through June (66% of normal), but more importantly, July, August, and early September brought almost no precipitation. This came on the heels of the 5th year of drought in northwest Montana. Approximately 136,000 acres burned within the park boundary, which was more than during the previous benchmark fire-year of 1910.

Seldom does everything burn within a fire perimeter. Some areas may be untouched by flames, while adjacent sections burn at a low to moderate severity. These areas will rejuvenate quickly. Other areas are fully engulfed, but will in time provide a vibrant habitat. The result is a dynamic blend of mixed severity burned and unburned forest called the forest mosaic.

Most animals, plants and trees in the Park have evolved with fire. Fire causes rapid change in a forest, creating openings that allow light to reach the forest floor where sun-dependent plants grow. Downed logs and duff on the forest floor are burned to ash, releasing nutrients back into the soil. Many flowering plants such as fireweed and lupine flourish after a fire. Older Ponderosa pine, western larch, and Douglas fir trees have thick bark that insulates the inner living tissue from the heat of a fire. Larch trees have additional fire adaptations. In an intense fire they can lose all their needles to the heat, and then can grow new ones and even replace burned branches along the bole of the tree. These survivors provide seed for reforestation. Other species depend on fire for reproduction. Lodgepole pines drop millions of seeds after a fire and produce vast stands of even aged trees, which can perpetuate a fire cycle on an 80-120 year rotation called a fire regime. Ponderosa pine germinates best on a mineral seedbed, which is provided by fire on a landscape scale.

It is rare for mammals to get caught in a fire. Larger animals are able to move out of the way and most small animals, amphibians and reptiles avoid fire by seeking refuge; i.e., in tunnels in the ground, under large downed logs, or in damp areas. Grazers (such as elk, rodents and ground squirrels) and browsers (such as deer and moose) find new habitat and succulent vegetation where only unpalatable plants grew previously. As these populations flourish, so do predators and scavengers. Birds that nest in cavities take advantage of dead snags and other birds thrive on the increase in insects found in decaying trees. Fire is a major ingredient in the ecology of the Northern Rockies just like the snow, the wind, the rain, and other natural forces. Wildland fire is an essential component of this ecosystem and native plants and animals are well adapted to it.

Where dense tree canopies previously shaded the ground, fireweed, lupine, pinegrass, spirea and willows will thrive in the newly nutrient-rich soil, creating a high-contrast landscape of blackened bark, bright flowers, and green plants. Some plants will re-grow vegetatively from corms, stolons, root crowns, rhizomes, or bulbs that survived in the soil. Shrubs such as serviceberry and huckleberry re-sprout after a fire producing a more vigorous plant, which increases fruit production. Lodgepole pine, Douglas fir and spruce may produce huge quantities of seedlings during the first few years after a fire.

The diverse stands of forest seen throughout the park are in different stages of regeneration and everyday move one step closer to a time when they will once again be blackened. Glacier National Park has been described as one of the most intact natural ecosystems in the lower 48 states. Fire has played a dominant role in creating the rich biological diversity. Without fire, Glacier Park's character would be forever altered.

The following information is courtesy of the Crown of the Continent Research Learning Center:

Wildland Fire - A Heated History

Wildland fire has been an integral part of the western landscape for millennia. In Glacier National Park, as well as the rest of the West, fires are naturally ignited by lightening with a cyclic occurrence, and forest and grassland ecosystems are adapted to this periodic disturbance. Therefore, nearly every existing forest in Glacier has had fire course through once or multiple times, or, has replaced a previously burned forest, or has invaded open areas that fire may even-

tually reopen. Fire on the landscape creates a diverse mosaic of vegetation and associated wildlife. Glacier has fires every year which burn anywhere from less than an acre up to the 146,000 acres burned in 2003. Man's relationship with fire on the land has had a very heated history. Before European settlement of the West, Native Americans used fire in the region for a variety of purposes. And, even today, a large percentage of fires are also started by people, both intentionally and unintentionally. Add more than 6,000 lightning-start fires that occur in the U.S. annually, and the potential for fire-starts can be great. The West has a history of drought as well as fire, and when lightning strikes a forested region or a prairie that has not received much moisture, large fires may result.

A general practice with early land management agencies was to stop all fires. Up until the 1960s, most managers and the public thought of fire as only a bad thing. Over the years, however, research revealed that fire was a natural process that improved habitat for many wildlife species and maintained certain forest types. Today, park staff employ a combination of suppression, prescription, and "wildland fire use" methods to manage fire across Glacier's diverse landscapes.

Natural Fire Regimes

While wildland fires are a natural part of Glacier's ecosystem, not all systems respond to fire in the same way. Fire behavior on a landscape depends on many factors, including slope and aspect of the terrain, recent burn history, long-term climatic conditions, and current weather. A major factor affecting the way a system responds to fire is the fuel, or type of vegetation, present. Different types of vegetation and vegetation mixes have different types of fire regimes.

The fire regime of an area is based on the severity and return intervals of fire across that landscape. In most instances, the more severe the fires, the less often they occur, and the less severe the fires, the more often they tend to occur.

The term "burn severity" generally refers to the amount of change in vegetation seen after a fire. For example, a low severity burn in a forest might burn just the underbrush and lower limbs of trees, while a high severity burn will replace the entire forest stand.

In Glacier National Park, there are several different fire regimes. Through research methods such as examining fire-scarred trees, counting tree rings, investigating present forest structures, looking at ash layers in the soil, and carefully documenting the extent of historical burns, we know what the fire return intervals are for various areas of the park. Grasslands and long needled pine forests like ponderosa pine, of the west side, usually burn about every 9-29 years with low severity fires. Lodgepole pine forests, found in the North Fork area on the western side of the park, burn in 60- to 80- year intervals, usually with high severity. High elevation mixed conifer forests may have as long as 250 years between burns.

Despite active fire suppression over the last century, much of Glacier's ecosystem is still within natural fire regimes. Historic fire return intervals for the majority of the forests in the park are longer than the amount of time that effective suppression techniques have been used. Therefore, there has not been a significant alteration of Glacier's natural fire regimes as there has been in other areas of the United States, such as in the southwestern ponderosa pine forests.

Glacier's Management Strategy

Since the necessity for fire in a fully-functioning, western ecosystem has been recognized, Glacier's fire managers try to allow naturally ignited fires to burn whenever possible. However, this is not always feasible. There are many situations where it is merely too dangerous to allow a fire to burn unchecked. Such situations include weather conditions that might allow the fire to spread quickly, fires too close to structures or park boundaries, or when there is so much fire activity nationwide that the park could not call for sufficient help should they need it.

A naturally occurring fire that does not threaten people, structures, or property is managed for resource benefits, when possible. Even then, the fire is carefully monitored and managed. Since 1994, the park has followed an "Appropriate Management Response" with all fires. Fire managers set parameters within which a fire will be permitted to burn, allowing the most benefit with the least amount of risk. If fire conditions change and result in unacceptable fire behavior that threatens park resources or the boundary, managers may elect to suppress portions of the fire.

The fire management staff has one additional tool that can be effective. Occasionally, for limited projects, they can set "prescribed fires" within the park, to meet specific objectives, such as fuel reduction or returning fire to dependent vegetation types. Fires planned and started by fire managers aim to return the process of fire to that ecosystem. By bringing back wildland fire to many areas of the landscape where fire has been historically suppressed, managers are helping to improve wildlife habitat, perpetuate grassland and forest communities, and promote ecological diversity within the ecosystem.

ANIMALS

Like plants, animals are affected by environmental influences such as landforms, climate, and availability of food and water. The great diversity found in the Waterton-Glacier International Peace Park area is mainly due to the overlap of habitats between the mountains and the prairie – and the great junctioning of five floristic provinces.

As human developments continue to fragment wildlife habitat, Waterton-Glacier and other national parks have become more important to wild animals that require space, prey, and human tolerance. Nevertheless, even within the refuge of large parks, many species are so far ranging (birds, bears, wolves and ungulates, to name a few) that the long-term reality is the need for interagency cooperation in ecosystem management planning. The baseline information that the parks offer through monitoring and research comes to play once again.

Review of the earliest records suggests that wildlife composition, at least for mammals and birds, has changed little since the parks were established. Species known to have been extirpated include mountain bison and mountain or woodland caribou. Nonnative species include the ring-necked pheasant, rock dove, starling and house sparrow; however, none of these species is widespread or abundant. Raccoons and blue jays have expanded their ranges into the W-GIPP area as have the turkey (introduced in different areas of the state/province).

The park provides important year-round habitat for many wildlife species. Grasslands, shrub-

lands and riparian areas provide winter range for deer, elk and moose. Grasslands and forest environments provide spring range for deer, elk and grizzly bears. As spring progresses into summer, deer and elk move to higher elevations following the green-up of vegetation. The higher elevations also provide summer habitat for grizzly bears, bighorn sheep and goats. Low elevation valleys in the fall and spring provide habitat for almost all terrestrial wildlife species.

There are many documented migration routes for raptors (birds of prey) that follow mountain ranges and ridges in Waterton-Glacier. These are significant travel corridors through which, using rising thermals and updrafts from the mountains, thousands of birds make their semi-annual migrations to winter or summer ranges. A vast majority of the birds are golden eagles, with some bald eagles and hawks mixed in. During the autumn of 1996, over 3,000 raptors were counted at one site during September, October and November as they crossed high above the upper McDonald Valley. The parks may be along one of the largest golden eagle migration corridors in North America. This needed air space, a necessity for what some researchers indicate are declining populations of raptor species, is an interesting and no less important “habitat” requirement that must not be compromised by inappropriate human activities, especially within the protected “domain” of a national park. This is an excellent example of a management concern that requires cooperation among varying interest groups and managing agencies.

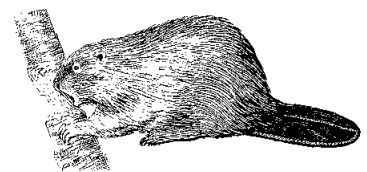
Good opportunities to see wildlife tend to be seasonal. The key to successful wildlife watching is being at the right place at the right time and having the proper equipment such as binoculars. In fact, one of the best ways to see wildlife is to use binoculars and patiently scan open areas. In the high country, this technique can reward the viewer with sightings of bears, bighorn sheep, marmots, mountain goats, eagles and much more. One animal house we routinely see on our field trips are beaver lodges.

Beavers

Beavers are members of Rodentia, the largest mammal order. Rodents are gnawing animals and have two pairs of prominent, chisel-shaped incisor teeth. These teeth grow continuously and maintain their sharp edges; they must be used frequently for gnawing or they will become too long.

The beaver, weighing up to 60 pounds, is the largest North American rodent. Beavers are excellent swimmers and can be easily identified by their scaly, flat tails. The tails are used for steering while swimming, and bracing them on land as they gnaw trees. Their back feet are webbed and used like paddles when swimming. Beavers move slowly on land, where they are prey for coyotes and mountain lions. Being excellent swimmers, they are safe from predators while in the water.

Beavers often dam streams to create deep ponds. They then build a lodge in the pond near the bank. On large streams and rivers, however, dams are not constructed. To build a dam and make a pond, beavers cut down trees and bushes with their sharp teeth. They take branches in their mouths and pull them into the water. Holding the branches with their teeth and front paws, they push the branches into the



mud at the bottom of the creek. They dig up mud from the creek bottom and pile it on top of the branches to fill up the holes. This continues until the beavers have constructed a strong dam. Water builds behind the dam creating a pond.

The beaver lodge is similar in construction to the dam. A large pile of branches and mud is piled until it is higher than the surface of the water. The beavers swim to the bottom of the pond and gnaw up through the pile until they have made a tunnel that reaches above the water line. There they make a living chamber lined with leaves and grass. Beavers are monogamous and work together to choose the spot to build a dam and lodge.

Beavers eat the inner bark or cambium layer of branches of deciduous trees. Preparing for winter, beavers cache branches in the water. When the pond freezes, the store of food is easily available to them.

When beavers dam a stream, they set in motion a form of succession. The resulting backwater floods lowland near the creek. Trees are soon killed, creating an opening in the forest canopy. Water-associated plants and shrubs quickly invade the pond and shoreline, creating favorable habitat for waterfowl, moose, blackbirds, amphibians, fish, insects, muskrats, wading birds, warblers, marsh hawks, and a score of other animals. After many years the water becomes shallow, filling in with silt and plant debris.

Stimulated by the nutrient-rich mud, grasses, sedges, and shrubs begin to choke the water with their accumulating debris. The ground begins to firm as more silt is trapped.

As years pass, the trees near the lodge are cut down by the beavers for use as food and shelter. The beavers must move on and find a new spot to support themselves. Without the beavers to keep it strong, the old dam collapses, draining the pond. The area becomes meadow, supporting grasses, sedges, and other flowering plants. Trees begin to re-invade the drier ground and eventually the meadow reverts to forest. Centuries may be required to see this process completed.

At each stage, many of the animal inhabitants change because the habitat has changed. The robin and the red squirrel in the original, pre-beaver forest give way to the heron; the heron is replaced by the insect and berry eating cedar waxwing; the waxwing is followed by the tree-dwelling robin and red squirrel once again.

NATIVE AMERICANS

Recent archaeological surveys have found evidence of human use dating back over 10,000 years. These people were probably the ancestors of tribes that live in the area today. By the time the first European explorers came to this region, several different tribes inhabited the area. The Blackfoot Indians controlled the vast prairies east of the mountains. The Salish and Kootenai Indians lived and hunted in the western valleys. They also traveled east of the mountains to hunt buffalo.

The Blackfeet

The Nitsitapii (“real people”), collectively called the Blackfoot, comprise three distinct groups: the Blackfoot or Siksika, the Blood or Kainai, and Piegan or Piikani. The collective use of the names Blackfoot in Canada and Blackfeet in the United States developed because it was the Siksika, the most northerly group, who first met the European traders. Today, the Siksika reside on the Bow River near Calgary, the Kainai near Cardston and the largest group, the Piikani are separated into two groups, the North Piikani near Pincher Creek and the South Piikani in northern Montana. In modern times, the northern Montana group is referred to as The Blackfeet Nation or The Blackfeet Tribe. Many Blackfeet descendants live and work on the Blackfeet Indian Reservation which shares Glacier’s eastern border.

A highly nomadic people, the Blackfeet were deeply connected to the hunting of bison on the plains and based much of their livelihood on the resources of the mountains and eastern foothills. The yearly cycle of the Blackfeet began in early spring as individual bands left their winter camps to begin an intensive season of hunting and root collecting. Women and children went to the mountains to dig for roots, while small bands of hunters moved east, seeking bison. Food gathering continued through the summer until the annual Sun Dance celebration, when the various bands would convene for several weeks on the plains. At the conclusion of the Sun Dance ceremony, the various bands would disperse again; some returned to bison grounds, while others headed to the mountains to hunt elk, deer, bighorn sheep, and mountain goats, to cut lodge poles and gather berries. As fall arrived, the bison moved west and north to their wintering grounds, and some Blackfeet bands would reassemble into larger groups for communal hunts. The annual cycle of hunt and harvest would end with the establishment of winter camps in heavily wooded river valleys near the mountains, sheltered from the severe northerly winds that swept the open plains.

The Kootenai

From west of the divide, the group most frequently associated with Glacier National Park is the Tobacco Plains Band, once located near Eureka, Montana. These people hunted and quarried workable stone (chert). Linguistically and culturally, these people, the Kootenai (spelled various ways including Kootenai, Kootenay and Kutenai), are a people unto themselves, with origins difficult to trace. Skilled hunters, trappers, and fishermen, the Tobacco Plains Band historically traversed the mountains on annual bison hunts into the Waterton area, utilizing crucial mountain passes. Today, the Kootenai are part of the Confederated Salish and Kootenai Tribes (CSKT) and many live and work on the Flathead Indian Reservation along Flathead Lake.

Other Native Americans

Other tribes that occasionally used the area that has become Waterton-Glacier International Peace Park include the Salish, the Stoneys (Assiniboine affiliate), the Gros Ventre (Arapaho affiliate) and the Cree.

Create A National Park

Vocabulary

National park, natural resources, cultural resources

Methods

Students create a mini-national park in a specified outdoor area, marking a nature trail and providing visitors with information about the park.

Materials:

For each pair of students:

- * Clipboard
- * Paper, pencil
- * Hand lens
- * Fifteen-foot piece of string
- * Six popsicle sticks
- * Poker chips (at least one per student)

Objectives

The students will be able to: a) Give three reasons why national parks are needed, b) Describe characteristics of a national park, c) List three problems facing national parks, and d) Analyze the information learned and write a persuasive proposal for a national park designation.

Background

There are over 390 national park areas in the National Park System. They have been set aside by Congress to preserve and protect the best of our natural, recreational, and cultural resources for the use and enjoyment of all persons, including future generations. For this lesson, we will be discussing parks set aside for their natural wonders. These parks are as diverse as the visitors who come to them. A park may offer any one or a combination of the following: camping, wilderness hiking trails, scenic overlooks, nature trails, campfire programs, boat tours, canoeing, fishing, boardwalks, rock climbing, swimming, or tours of historic buildings and cultural sites.

A park may have several outstanding natural features for which it was set aside, or it may be preserved for a specific site. Park management is set up much like a school system, the rangers being the teachers. Each day brings new challenges to a park and its resources. Some parks may have numerous problems facing them.

Upon arriving at many of the national parks, the visitor pays a small entrance fee and is handed park information outlining major resources and sites to visit. Larger parks have a visitor center where rangers disperse information about the park. One part of a park ranger's job is to interpret the park resources and problems to the visitors so that they can understand the concerns of the park. Why? Because parks belong to the people and they must learn about these valuable resources and how to protect them!

Procedures

1. Discuss the concept of a national park with your students. Ask students if they have ever been to a national park. What makes it different from a state park or a county park?
 2. Ask students what they would like in a national park, if they were to create a "perfect park." Why set up a national park? Who owns national parks?
 3. Pair off the students. Distribute the materials listed on the preceding page to each pair.
 4. Assign, or let each pair choose, an outdoor spot for their national park. Using their string, they should rope off the area.
-

5. Students must move about their national park on hands and knees. Using the hand lenses, the students should choose the scenic values of their park; a hole might be a canyon, a rock might be a mountain, for instance. The popsicle sticks can be used to mark the trails or scenic spots.
6. Give the class 20-25 minutes to set up the trails in their park. After the students have marked their parks, they must make a brochure (including a map) to publicize their park.
7. Once the parks are ready for business, the “rangers” (the paired students) must advertise their park. They should advertise their park by shouting out its attributes. Ask the pairs to split up. One student in the pair should remain in the park to interpret it, while the second visits other national park. The students may then switch. The poker chips are the entrance fee needed to visit another national park. Every student must visit at least one national park.
8. After they have visited the national parks, ask students the following questions: Did they have problems getting visitors to come to their park? Were visitors always careful with the parks’ resources? Did they have too many visitors? What would they change? What problems occurred? How would they raise money to improve the park’s facilities?

Evaluation

Discuss why we should have national parks. What can you do to help protect the resources in a national park? Who has the responsibility of preserving and protecting the park for future generations?

Extension

Write a proposal to get funding to buy a national park. Presentations should be made to the “President” (teacher).

Show students how they can participate in the online “Web Ranger” program at www.nps.gov or in a national park “Jr. Ranger” program the next time their families visit a national park.



Locating Glacier National Park

Materials

- * Copies of the map of Glacier National Park and vicinity.
- * Copies of the map of the Pacific Northwest and Western Canada.
- * Copies of the map of North America.
- * Transparencies of the above maps.
- * List of landmarks to locate (in bold type in procedures)
- * Colored pencils, crayons and/or markers.

Vocabulary

Alberta, Blackfeet, British Columbia, Canada, Continental Divide, Kootenai, national forest, national park Indian Reservation, Peace Park, Salish, triple divide, watershed.

Method

Students will locate and identify landmarks within and surrounding Glacier National Park in ever greater geographic areas on three maps: 1) Glacier National Park and surroundings, 2) the Pacific Northwest and Western Canada, and 3) North America. Students will label and color the three maps.

Objectives

- Students will be able to locate Glacier National Park and other landmarks within the state of Montana in relation to: a) the Continental Divide, b) Waterton Lakes National Park, c) Alberta and British Columbia, d) the three divides :Pacific, Hudson Bay and Gulf of Mexico, and e) the students' community.
- Students will also be able to locate Glacier and Montana in relation to the Pacific Northwest (US) and Pacific West (Canada).
- Students will locate Glacier and Montana in relation to North America.
- Students will identify the water-bodies that Glacier's water ultimately flows into.



Background

Even before Glacier National Park was established in 1910, it was an important cultural and economic contributor to the state of Montana. The scenery of the area attracted visitors well before the park was established. They came to the area by train. The Great Northern Railroad (now Burlington Northern Santa Fe) still runs along the southwest border of the park, and Amtrak still carries visitors to the depots that the Great Northern built at **East Glacier**, **Summit Station**, **Belton** (now **West Glacier**) and **Whitefish**.

For the Native Americans whose homelands encompassed Glacier, the area has great spiritual significance. The Blackfeet, for instance, refer to the mountains here as the "backbone of the world." The translation of the Kootenai name for the **Lake McDonald** area refers to it as "a good place to dance." Today, the **Blackfeet Reservation** shares Glacier's eastern border. The Kootenai, Salish, and Pend d'Oreille are part of the **Flathead Reservation on Flathead Lake**.

Glacier National Park straddles the **Continental Divide**. The divide defines watersheds. West

of the divide water flows into the **Pacific Ocean** and east of the divide water flows into the **Gulf of Mexico** and **Hudson Bay**. Because water from the park flows into three different directions, Glacier contains a rare geologic feature - a **triple divide**. The water that comes from Glacier on its way east or west passes through many different places. The people and animals that live around Glacier depend on the water that comes from the park. For instance, **Lake McDonald** eventually flows into the **Flathead River** which flows into **Flathead Lake**. Along the way that water passes through **Columbia Falls** and **Kalispell**.

The Flathead National Forest is on Glacier's western and southern boundaries. The Blackfeet Indian Reservation is on the eastern boundary. To the north of Glacier are the Canadian provinces of **Alberta** and **British Columbia** in **Canada**. On Glacier's northern border in Alberta is our sister park, **Waterton Lakes National Park**. In 1932 the two parks were merged to become the world's first International Peace Park.

Procedures

1. Using a globe or North American map, introduce students to the location of Montana in the United States and in North America. Point out the location of various landmarks - Rocky Mountains, Canadian Border, the Pacific Ocean, Gulf of Mexico, and Hudson Bay, the plains of eastern Montana.
2. Then, using the transparencies, for the United States and North America see if together as a class, you can locate and label those same landmarks.
3. Discuss the location of the students' hometown on the map of Glacier and vicinity. Also discuss the location of various protected lands within Montana - national forests, national parks. Point out the Indian Reservations, the three watersheds, and major rivers.
4. Distribute a copy of the three maps to each student. Decide in advance which things on each map you want them to be able to label. On the North American map they can label the oceans, countries, and state of Montana. On the Pacific Northwest map, they could label the Canadian provinces, American states, and the ocean. On the Glacier map, they could label their hometown, the rivers, the lakes, and the three watersheds.

Evaluation

On a road map have students trace the route from their school to Glacier National Park. Have them do the same for other landmarks on the map as well.

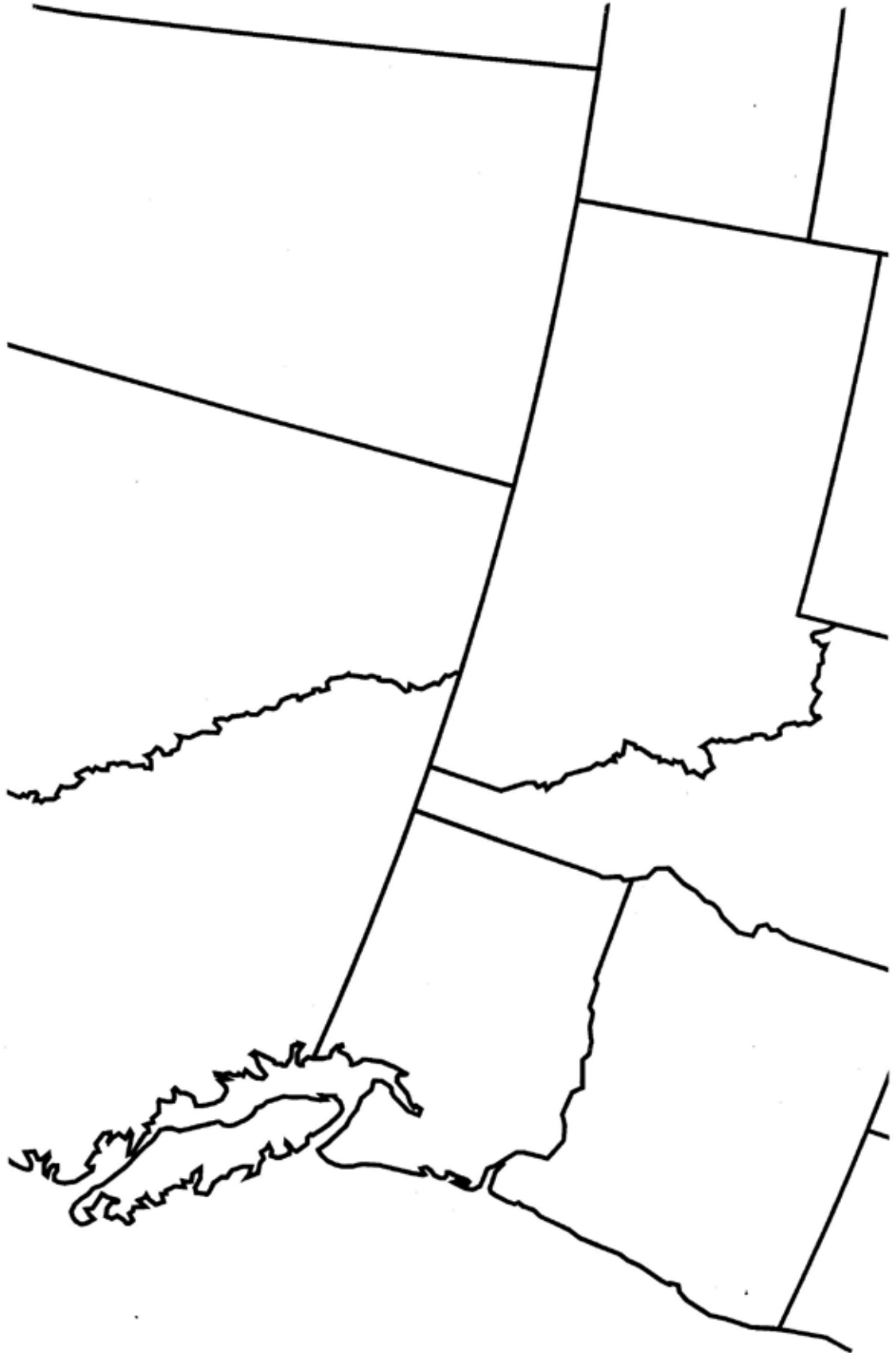
Extension

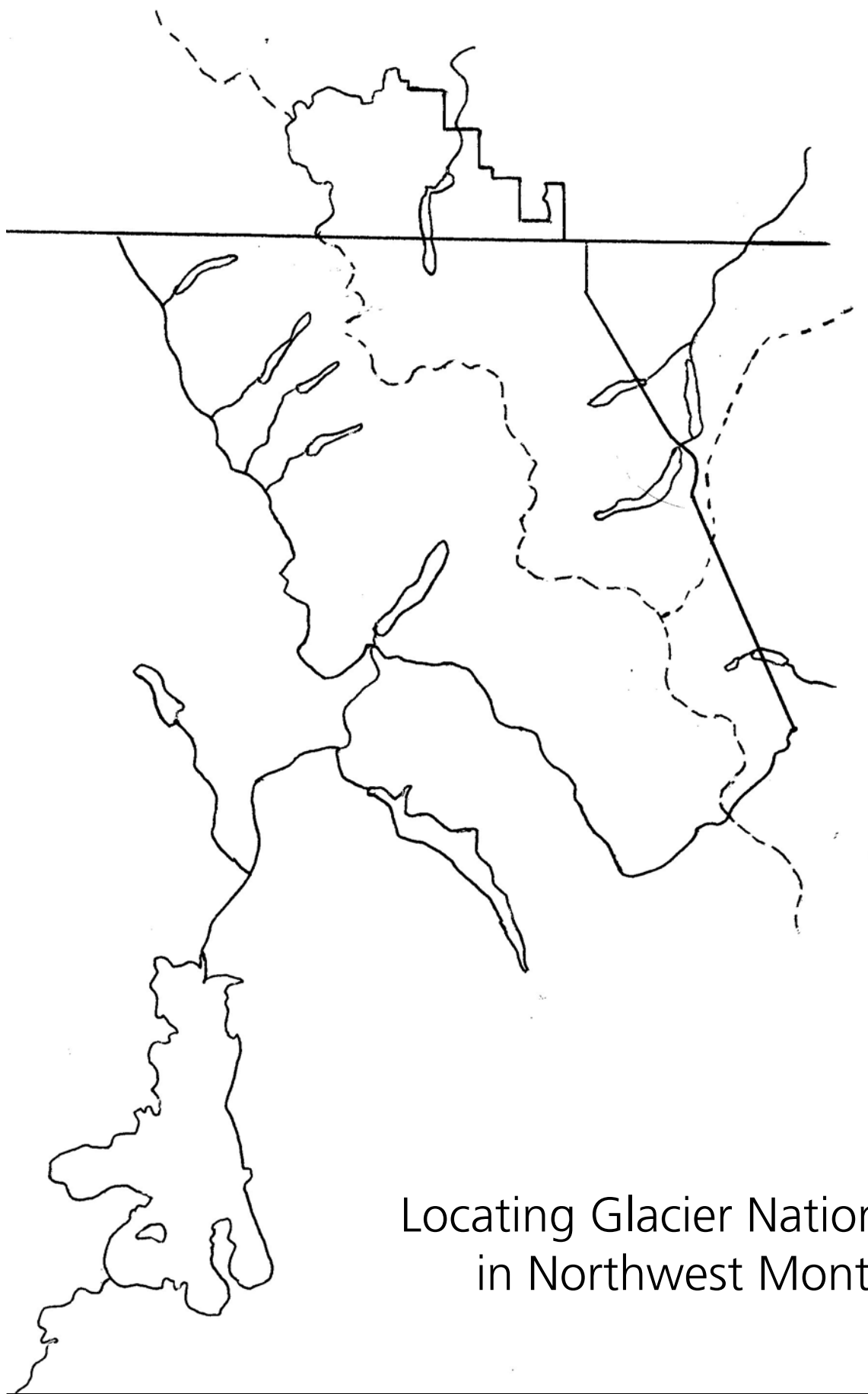
Discuss the importance of the geographic location of Glacier National Park. Have students hypothesize as to why certain types of plants and plant communities live in the park. What about the different animal species that live in Glacier?

Locating Glacier National Park in North America



Locating Glacier National Park in the Pacific Northwest





Locating Glacier National Park
in Northwest Montana

What is Wild?*

*from the Wilderness Land Ethic Curriculum, Arthur Carhart National Wilderness Training Center.

Vocabulary

Wilderness, habitat, national park, protection

Materials:

- * 3 large writing papers
- * Magazines (to cut up)
- * Crayons
- * Glue
- * White board or chalk board

Method

Students participate in a guided imagery exercise and take a trip to an imaginary “wild” place.

Objectives

- Students will identify similarities and differences between their home and wild environments.
- Students will demonstrate awareness of wilderness as a place not developed by or for humans.

Background

In 1974 President Nixon recommended to Congress most of glacier National Park be designated as Wilderness. Congress has not acted on that proposal but 95% of the park has been managed as wilderness since 1974. (Presently, all developed areas are excluded from proposed wilderness.) Many children have never visited wilderness, though they may have images from stories or movies of what such places would look like. Drawing on students' own experiences and perceptions, these activities introduce the concept of wilderness by comparing wild places to developed places. The levels of distinction students make will vary with their experience, age, and the location of your community. A good definition of wilderness for young children is that of a place influenced by the forces of nature, where people visit, but do not live. The Wilderness Act of 1964 defines wilderness “in contrast with those areas where man and his own works dominate the landscape, as an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain.” Rod Nash, wilderness historian, believes that wilderness is so heavily weighed with meaning of a personal, symbolic, and changing kind that it is difficult to define.



Procedure

1. Share with your students your own definition of “wildlands” or “wild place.” You might also want to ask them to share their perceptions of these words with you. For older students, ask them to write down five or more words they associate with wilderness. Write all the words on the board. Explore the feelings associated with the word “wild.” How does the word make you feel? Then add “erness”. Wilderness areas are places that are wild. Glacier is considered a wilderness. If possible, show students photos from the photo gallery at the Glacier website at www.nps.gov/glac or look at the webcams for a live view of Glacier. You can also take an eHike up to

Avalanche Lake to experience some of Glacier's wilderness.

2. Tell students that in preparation for your field trip to Glacier National Park, you are going to take an imaginary trip today to a place that is wild. Create your own story or use the following scenario to stimulate students thinking. Students could quietly act out the story you describe. You may even wish to arrange chairs as the seats of a school bus and have students "climb aboard."

"Imagine we are all going to put on our warm clothes, and pack our backpacks with our lunches and drinks for the day in the wild. We are going to travel in our magic school bus...everyone aboard and take a seat! We'll drive through town and past neighborhoods until we can't see highways, stores or gas stations. We drive a long time. It is such a long way, that everyone goes to sleep! The bus keeps moving until finally it stops at the edge of a wild place. You can hear a few quiet sounds. It smells clean and looks all green. Before you open your eyes, make a picture in your mind of what you might see in this wild place."

3. On one paper labeled "wild" write down images as students share them. Encourage students to be specific in their descriptions. Also have available a paper labeled "developed" and record things students saw as they were leaving their school/city. For example, people belong in both places, as well as plants and animals. But the types of plants and animals may differ and the numbers of them and/or people may be different.

4. Review the words generated in the above activity and use magazines and the animal drawings in this guide to make collages of things that might be found in a wild place as well as things found in developed areas around cities and towns. Remember to point out that we all share the same air, water, soils, and scenic views that are exchanged between wild and developed areas.

5. Have them think about how Glacier National Park has been designated to be a wild place and some of the reasons why we need wild places (peacefulness, home for wild animals, place to study nature, clean water source, etc...).

Evaluation

Have students share ways their home is different and similar to a wild place.

Extension

- Come on a field trip to Glacier National Park!
 - Look at maps and see what other wilderness areas exist in northwest Montana. What about other areas of the state?
 - Borrow the "Wilderness Trunk" from Flathead National Forest to find more resources and lessons about wilderness.
 - Download "The Wilderness Land Ethic Curriculum" from the Carhart Training Center website at <http://carhart.wilderness.net/>
 - Look for more storybooks in your library about wilderness.
-

Surviving in the Wild*

*Modified from the Wilderness Land Ethic Curriculum, Arthur Carhart National Wilderness Training Center.

Vocabulary

Wild, domestic, tame, pet, habitat, national parks, wilderness.

Materials:

- * Animal drawings from guide
- * Index cards
- * Magazines with animal pictures
- * Yarn
- * Paper for collages
- * Colored paper for bingo option

Method

Students role play a day in the life of a pet animal and then sort pictures of a variety of animals into “wild” or “domestic” categories with the option of making collages of each category. They will think about how “wild” animals are different from domestic animals and why wild animals need “wild” places to live. Materials for animal clue cards, bingo, and a 20-question-like game are given to extend the activity and learn more about the animals that live in Glacier.

Objectives (students will be able to)

- Describe the basic needs of all living things.
- Define differences and similarities between wild and domestic animals.
- State in their own words why wild animals need wild places to live.
- Learn about some of the wild animals that live in Glacier National Park.
- Name one way (adaptation) plants and animals have to survive winter in Glacier.

Background

Students often have a special interest in animals. They are familiar with animals in zoos, nature films, and their own pets. They often have the misconception that the rangers in Glacier National Park feed and take care of the animals that live here just like they do for their pets. In fact, the rangers take care of the animals’ habitat and then the plants and animals can survive on their own. Wild animals are very different from pets. A pet is a domesticated animal kept for companionship or amusement. A domestic animal is one whose breeding is largely controlled by humans. Evolution of a domesticated species therefore results mainly from artificial selection, with natural selection playing only a subsidiary role. The process of domestication implies the separation (partial or complete) of a breeding stock from its wild forebears.

This has extremely significant consequences in terms of raising animals in captivity. Domestic animals have been bred (over thousands of years, possibly 10,000 years in the case of dogs) to have characteristics that make them compatible with people. Some of these characteristics are physical (amount and distribution of meat, size, shape changes, coat characteristics); others involve selecting for “personality” traits that are desirable (docility, tractability, etc.).

Almost without exception, animals that have been successfully domesticated come from wild stock that is very social (usually living in social groups). The herd social structure tends to provide the correct basic characteristics that are selected for compatibility with people. So, animals like raccoons largely lack the basic personality characteristics to become good domestic animals.

The following animals meet the definition of domestic as presented above: dog, cat, sheep, goat, cattle, pig, donkey, horse, camel, llama, alpaca, ferret, guinea pig, rabbit (one species), chicken, turkey. A tame animal has been brought from wildness into a domesticated state. People need to provide for their pets and domestic animals because they have not been bred to care for themselves in the wild.

The activities in this lesson move students from an understanding of the basic needs of all living things to a recognition of the differences between the ways wild and domestic animals meet these needs, to an increased awareness of the importance of preserving wild places and undeveloped areas that maintain a diversity of wild species.

Procedure

1. Ask students to think of their favorite pet or a pet they know (if they don't have a pet). Tell them they will act out this pet as you describe the activities it goes through each day. Begin with all children as animals sleeping. In your description include waking up, stretching, playing, drinking, exercising, interacting with others, eating, keeping warm, and having a bed or shelter. Conclude with the students going back to sleep.
 2. Have students share the pets they chose and what they did during the day.
 3. Next, ask them to think about some of the things they needed when they were pets, and make a list on your paper. Focus student's attention on categories of food, water, shelter, and living space.
 4. Explain that these are the same basic needs of plants, people, wildlife, and domestic animals although they meet their needs in different ways.
 5. Compare the students' pet animals to wild animals, reminding students that wild animals have the same basic needs, but they take care of themselves in wild places, i.e., predators hunt and grazers find grass and run from predators. Come up with your own definitions for wild and domestic with older students. Have students act out a wild animal walking, hunting, eating, etc. Discuss animals that are predators, hunters or grazers. Show them an overhead of the "Adaptations" blackline master of the different parts of the beaver (or the hemlock tree) that help it to survive in the wild. Older students can fill in the student page as you point out the different adaptations.
 6. Show pictures of other animals or name a few and have students verbally categorize them as wild or domestic. Tame or captive animals may be confusing category. Tame animals are defined as "animals brought from wildness into a domesticated state". To help distinguish them, ask the questions: in their natural home, would there be people taking care of them? Could people take care of them in a wild place?
 7. Have students collect pictures of animals both wild and domestic or use photocopies of the animals drawings in the back of this guide, or have them draw their own. Then see if students can divide the pictures:
-

Make two circles of yarn on the floor labeled “wild” and “domestic” and have students place their pictures in the appropriate circle and explain why. You could also make two large class collages of these categories.

8. Use the following questions in your discussion: What are some of the differences between the two groups? Similarities? What about domestic compared to tame animals? If you are out camping and find a den of baby raccoons, what should you do? What is “best” for the animals? (It is generally best to leave wild animals where you find them, due to the difficulty in meeting their needs in a domestic setting, i.e. they can no longer be wild and meet their own needs, more information on this can be found at <http://www.isleauhaut.net/maskd/domestication.htm>)

9. Have students share their understanding of how wild places are important for the survival of wild animals. In a sharing circle or as a written activity, have students fill in the blanks: I would like to be a _____ (animal). I need _____ (adaptation) to help me to survive.

Evaluation, Extensions and Other Options

Use the wild and domestic page following this activity to have students circle which animals are wild and which are domestic. Then draw a Glacier animal or domestic animal they are familiar with.

Animal Clue Cards or Riddles

Have students learn about what kinds of wild animals live in Glacier National Park and the surrounding areas of northwest Montana. Students can create wildlife clue cards for Glacier animals by using the drawings at the end of this guide or finding their own pictures. Paste the drawing to one side of an index card and on the other side, use information from the resource section to make clues about the animal. See if students can “stump” the class with their animal clues. Example: “I look like a pet you might have at home, but I am not a pet. I am a very good hunter and can smell small animals through the snow (Coyote).” or “I am small but I can make a loud noise. I look kind of like a small rabbit and I live in the high mountains where I stay active in winter. I eat the grasses that I have stacked up all summer (Pika).”

Bingo Game Option:

Cut out the animal pictures and paste them to bingo cards. Again write clues (or use the animal cards at the back of this guide) about each animal. The teacher then reads the clues for the animal and the students cross off the matching animal picture for that clue on their bingo card and try to get 3 in a row.

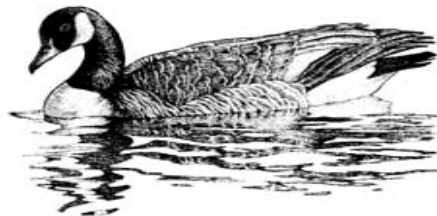
“Who Am I?” Game Option

Attach the name or picture of a Glacier animal to the back of each student. Do not let them see the animal. They then have to ask yes/no questions of others who can see what their picture is and try to guess the animal (similar to 20 questions). Help prepare students by giving them example question such as “Do I have fur?” “Can I swim?” “Do I hibernate?”

Wildlife Species Report Option

Ask students to identify, draw, and report on a wildlife species that lives in Glacier National Park and tell how it survives.

Below are wild and domestic animals. Circle the animals that are wild. Could some be both? Then draw a picture of a wild animal that lives in Glacier National Park and a domestic animal that you or a friend has at home.



A Glacier wild animal

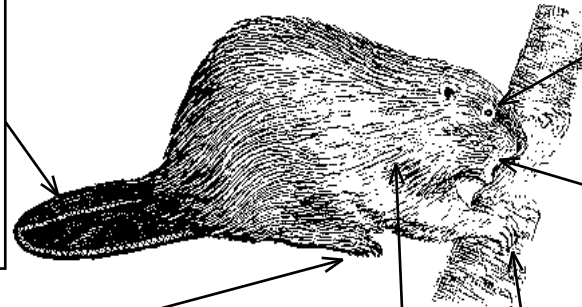
A domestic animal I know

Adaptations

Beaver

-Tail for slapping water for alarm
-Propeller for swimming
-Kickstand for propping up next to tree while chewing
-Place to store fat

Hind feet are webbed and help with swimming but not so good for travel on land.



Thick fur with shorter undercoat for warmth and longer, guard hairs to help repel water keep beavers warm and dry all winter. Beavers have more hairs per square inch than any other land mammal.

Eyes on top of head to be able to see what's above and extra set of eyelids that are clear to use while swimming.

Sharp teeth never stop growing, used to get to cambium food layer of trees and to cut down trees for lodges, dams, and to store in piles outside their lodges for food in winter.

Front feet are dextrous like hands, for grasping materials.

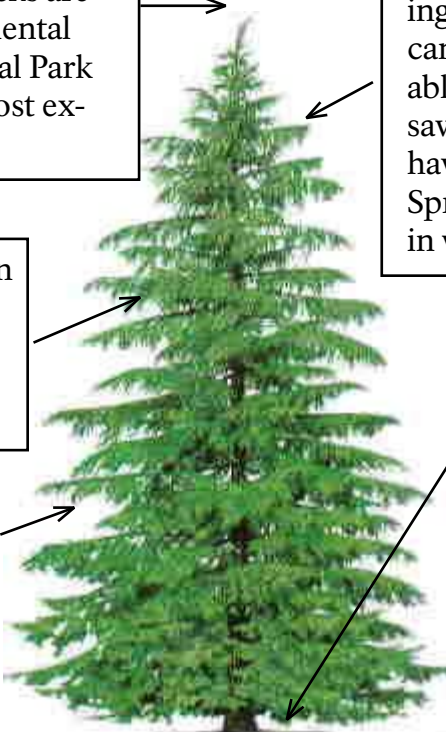
Western Hemlock

Easily identifiable by the leaning top. Western Hemlocks are found west of the continental divide in Glacier National Park and are at the eastern most extent of their range

Ever green needles have waxy coating to help conserve moisture. They can photosynthesize if water is available in winter (not frozen). Evergreens save energy in spring as leaves do not have to grow back like deciduous trees. Spruce Grouse feed on conifer needles in winter.

Branches slope out down allowing snow to fall off. They are also flexible if loaded with snow, they will bend and not break.

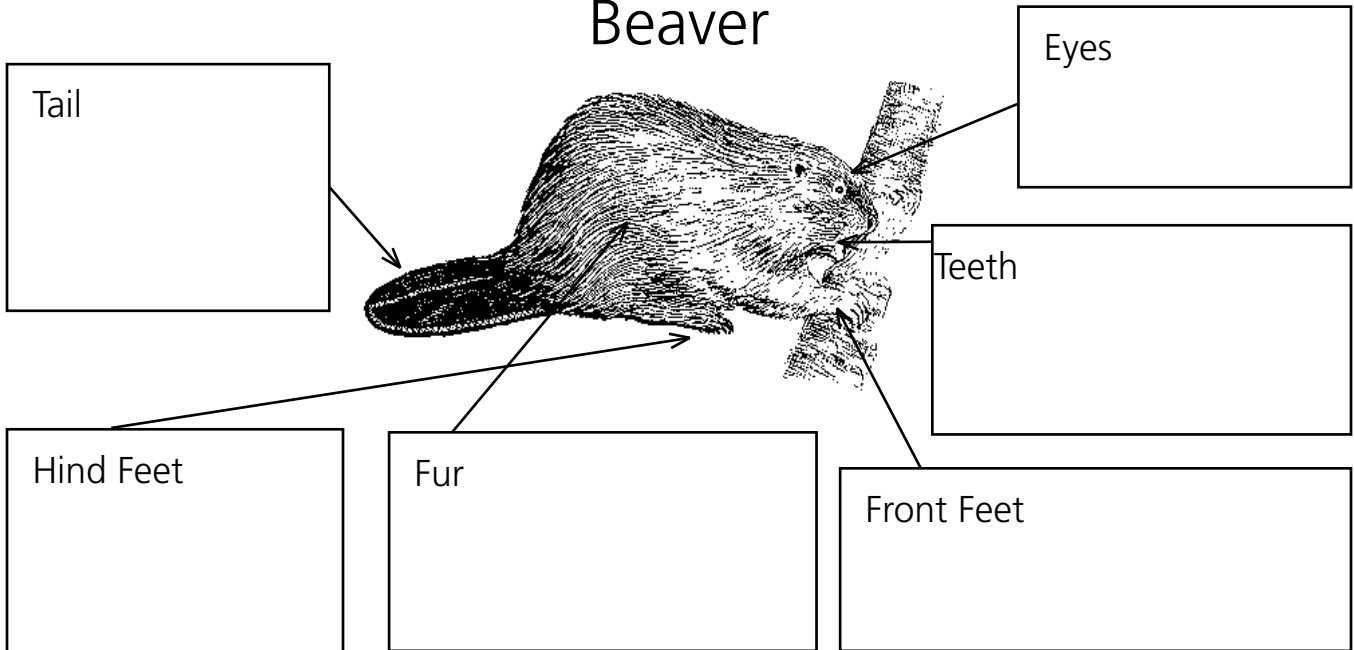
Woody shrubs and trees survive winter in a state of dormancy. Extra sugar in their cells protects them from freezing.



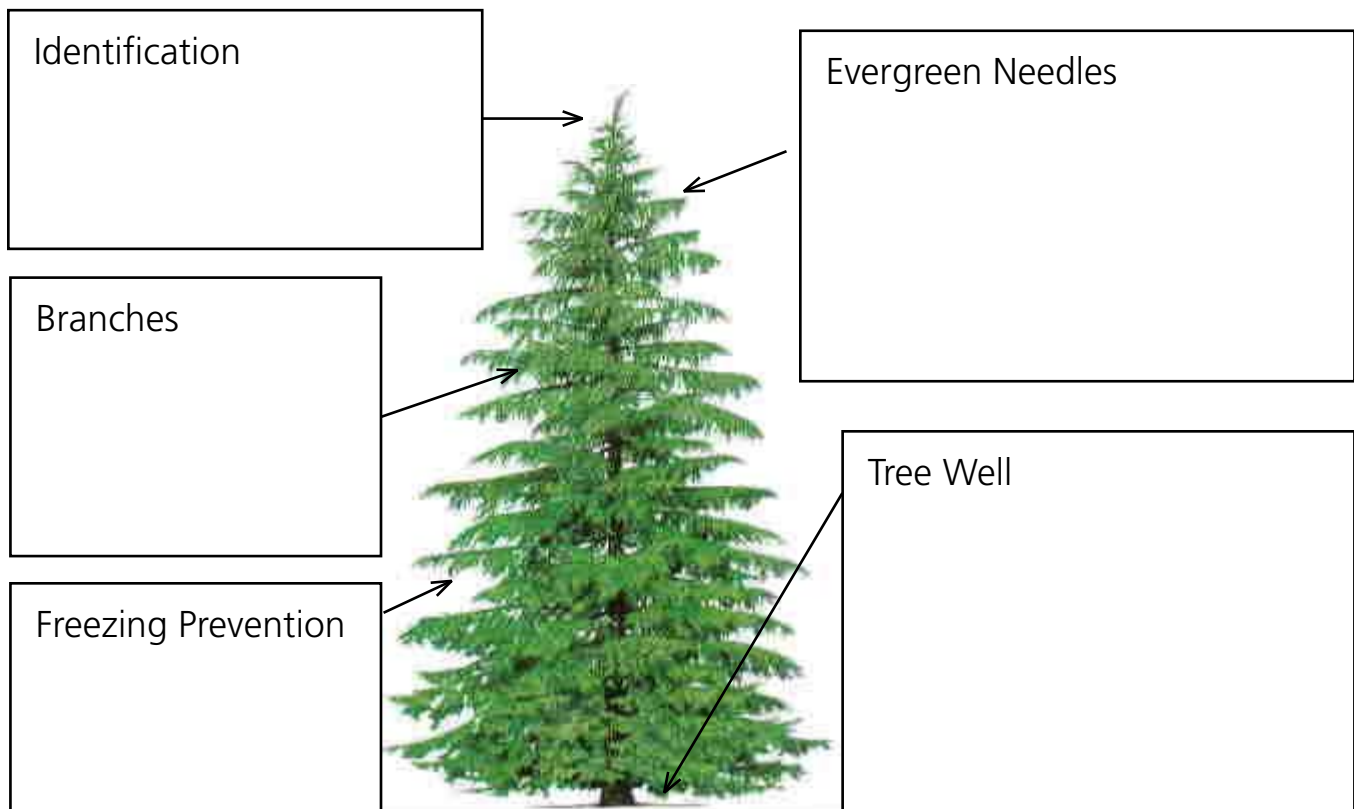
Tree well does not fill with as much snow because branches inhibit snow falling there. When snow falls off branches, a wall of snow can build up around the base of the tree and provide shelter from wind. It can also be colder when not enclosed and insulated by snow since cold air sinks and stays low to the ground at times in winter.

Adaptations - Student Page _____

Beaver



Western Hemlock



Who Eats Who?

Vocabulary

Food chain, food web, energy flow, producer, consumer, detritus, herbivores, carnivores, omnivores, predator, prey, leaf litter, decay, decompose

Materials:

- * Scissors
- * Animal Drawings in back of guide
- * Glue
- * Colored paper

Methods

Students make a paper chain and attach the sun as well as the appropriate plants and animals to make a Glacier food chain.

Objective

-Students will be able to make a food chain or food web of Glacier organisms.

Background

This activity helps students think through the concept of food chains and the need for energy to support basic life functions. All of our energy comes from the sun. We and other animals get energy by eating plants or other animals. By thinking about what animals eat or where they get their food energy, students will realize how plants and animals are connected through food chains.

Procedure

1. Show students the food chain example on the following page. Discuss how energy from the sun is converted from radiant energy into chemical energy by plants (through photosynthesis). When plants are eaten by insects, mice, deer, etc., the energy gets passed to that animal. Just like when we eat cereal for breakfast (or too much sugar) we get lots of energy. Wild animals in Glacier National Park need to be able to not only find water and shelter but enough food to help them have energy to stay warm, move around, and to reproduce.
2. Photocopy the animal drawings and line art pages from the back of this guide. Have students research where each animal gets its food energy (or help younger students find out who eats who by using the table included here).
3. When they know what eats what, have them cut 4 strips of paper from the colored paper. (They can fold the paper lengthwise once, and then again to make 4 sections) Have the students glue both ends of the paper strips together to make a ring. Then have them loop the next ring through the first, so that they create a "chain."
4. Make sure they start with a picture of the sun on the first link of their chain (they could draw it). Then the next link has to be an organism that uses the energy from the sun to make food (a plant or producer). Then the third link should be something that would eat that plant/producer, a consumer (like a deer). The fourth link will be something that eats the deer for energy (wolf, coyote, mountain lion, bear).

Evaluation

When the students “food chains” are done. Have them predict whether the animal at the top of their food chain would be able survive in Glacier. Ask them if that animal’s food is available in winter so that it would have energy to stay warm and be active year round in Glacier? Do they think it resists (stays and remains active), migrates (leaves), or hibernates (becomes inactive to conserve energy)? If there is no food, it is more likely that animal migrates or hibernates.

Extension

-Students can combine their food chains into food webs by attaching an animal link from their chain to an animal it eats in another person’s food chain. A third person can then see if they have an animal or plant that might be eaten by one of the organisms in the first two chains and attach those links.

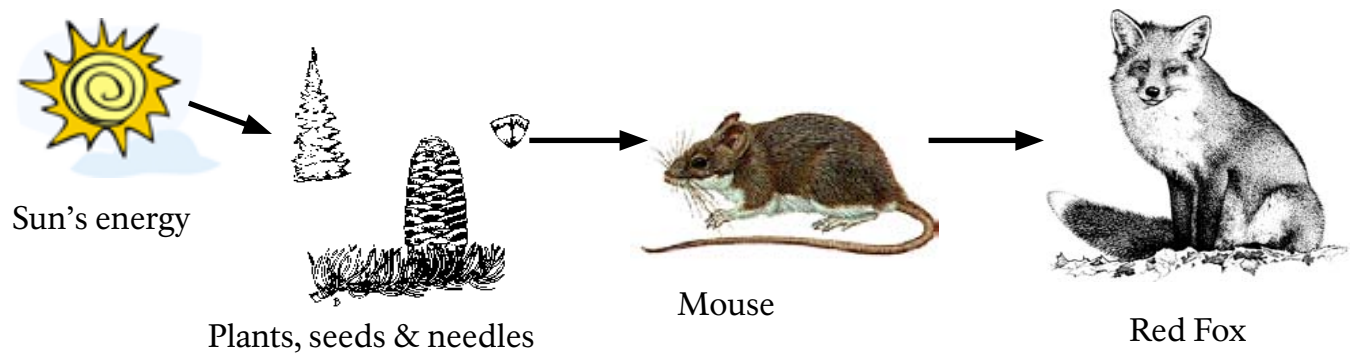
-Make picture cards of plants and animals that live in Glacier. Make sure you also have one of the sun. Give each student a card and have them stand in a circle so everyone can see each others’ cards. Start with the sun and hand them the end of a ball of string. They are going to pass the ball of string to something that depends on them to get/make food (should be a producer). Then that person has to pass the ball of string onto someone who depends on them for energy. Keep going in this way and see if you can get everyone connected in your “food web.” Discuss how if something disappears from the web (say insects) all the people who are connected to the insect need to set their string down. What happens to all the things connected to those people now? This can lead into a discussion of threatened and endangered species.

Who Eats Who?

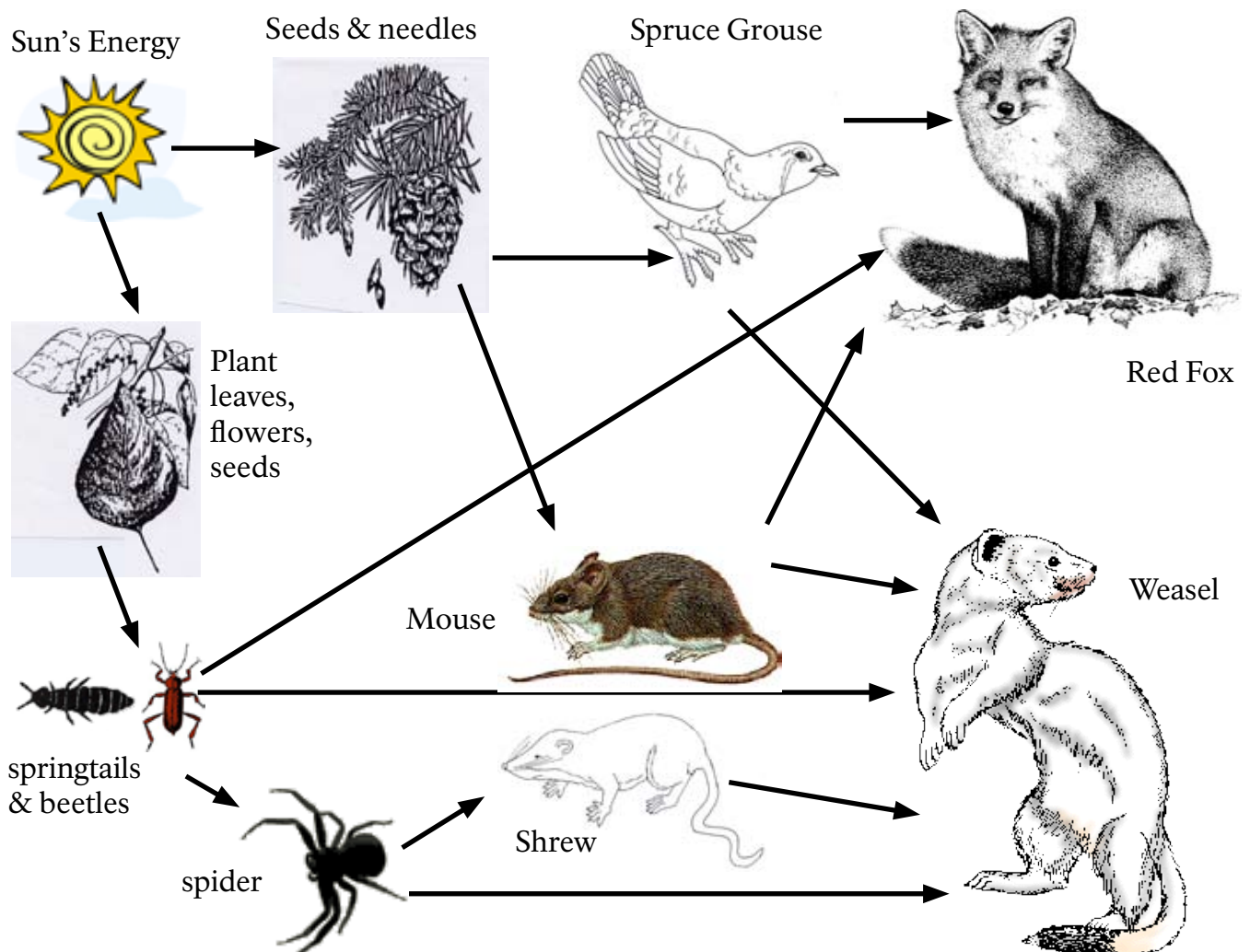
Animal/Plant	Eats	Is Eaten By
Grizzly bear	Rodents, Insects, Elk calves, roots, pine nuts, grasses, large mammals, carrion, berries	
Black bear	Rodents, insects, elk calves, pine nuts, grasses, other vegetation, berries, carrion	Wolves, Grizzly bears, Mountain lions, humans
Elk	Grasses, sedges, shrubs, aspen bark, aquatic plants	Wolves, Grizzly bears, Mountain lions, humans
Red Fox	Grasshoppers, beetles, crickets, berries, nuts, grains, mice, rabbits, birds, turtles, eggs, and even dead animals like road-kills	Bobcats, lynx, mountain lions, and wolves
Beaver	Grasses, sedges, inner tree bark	Wolves, bears, scavenger species, humans
Fungi	Decompose carrion and dead plant matter	Some small mammals
Bighorn Sheep	Grasses, shrubby plants	Coyotes, wolves, humans
Mountain lion	Elk, mule deer, small mammals	
Snowshoe hare	Shrubs, conifer needles	Lynx, foxes, bobcats, Great horned owls, coyotes
Buds and twigs		Elk, beaver, snowshoe hare, moose, deer
Fruits		Bears, birds, foxes, insects, coyotes, deer
Aspen		Elk, beavers, insects
Grasses		Elk, deer, bears, moose, rodents, insects
Snakes	Small rodents, tadpoles, fish, salamanders, frogs, worms, insects	Fish, birds, carnivorous mammals
Birds	Seeds, insects, berries, fish	Other birds, carnivorous mammals, snakes and squirrels, and weasels (bird eggs)
Aquatic insects	Other aquatic insects, aquatic plants, detritus	Fish, birds, amphibians
Eagle	Fish, carrion, ducks	

Animal/Plant	Eats	Is Eaten By
Ground squirrel	Fungi, roots, leaves, bird eggs, buds, insects, seeds, carrion, nuts	Weasels, coyotes, badgers, hawks, foxes, owls
Deer	Shrubs, grasses, aspen, conifers	Wolves, bears, coyotes, mountain lions
Terrestrial Insects	Plant material, other insects, blood (mosquitoes, ticks)	Rodents, weasels, foxes, martens, coyotes, fish, bears, birds
Pika	Grasses, lichens, sedges, conifer twigs	Coyotes, pine martens, hawks
Weasel	Rodents, Snakes, Ground squirrel, Insects, Birds, Frogs, Eggs	Hawks, owls, foxes, coyotes, humans (trapped for fur)
River otter	Fish, frogs, young muskrat	Humans (trapped for fur)
Pine marten	Rodents, eggs, hares, insects, shrews, berries, carrion, birds	Owls, humans (trapped for fur)
Shrew, Moles	Insects	Owls, coyotes, foxes, hawks
Mice	Seeds	Owls, coyotes, foxes, hawks
Yellow-bellied marmot	Grasses, seeds	Coyotes, foxes, bears
Coyote	Small mammals, carrion, Ground squirrels, Birds, Deer	Wolves
Cutthroat trout	Small fish, fish, eggs, small rodents, frogs, algae, insects	Bald eagles, Lake trout, osprey, otters, humans
Wolf	Hoofed animals (90%), beaver, hares	

Glacier Food Chain



Glacier Food Web



Visual Vocabulary

Vocabulary

Carnivore, community, ecosystem, environment, food chain, food web, habitat, herbivores, interdependence, inter-relationship, predator, prey, shelter, succession.

Materials:

- * Vocabulary list with definitions
- * Small pieces of paper with vocabulary words printed on them
- * Container

Method

Students review vocabulary through use of pantomime.

Objective

Students will be able to interpret and identify ecological concepts.

Background

The major purpose of this activity is to increase students' familiarity with terms that are important in understanding wildlife and ecological systems.

Procedure

1. Give students handouts with words and definitions on them. Discuss and encourage students to give examples of definitions.
2. List all the words on small pieces of paper and put them in a container.
3. Divide the class into groups of four. Each group draws one word from the container, looks up the definition using the handout, and decides how to pantomime that word. Allow about five minutes for the groups to prepare their mimes.
4. Groups of students then take turns miming their word to the class. Set a time limit of one minute per group.
5. The rest of the class may use the handouts as a guideline for guessing the word being mimed.
6. Groups gain one point for a successful miming (having their word guessed within the one minute time limit) and one point for guessing another group's mime correctly.
7. Continue drawing words as time permits, changing groups or having "star mimers" assist students who muddled their mimes.

Evaluation

Ask students to choose one of the vocabulary words and draw a picture of its meaning.

Variations

1. Go outside for this activity. The environment is conducive to learning ecological concepts and noise level less a problem.
 2. Define words together in class orally. List words and definitions on chalkboard. This encourages students to think and remember. Leave definitions on board, or erase, challenging the students and encouraging memory retention.
-

What's That Habitat?

Vocabulary

Habitat, food, water, shelter, space, arrangement.

Materials:

- * Drawing paper
- * Crayons

Method

Students draw pictures of peoples' and animals' homes, comparing basic needs.

Objective

Students will be able to identify their own basic needs for food, water shelter and space in a suitable arrangement, and generalize that wildlife and people have similar basic needs.

Background

The major purpose of this activity is to familiarize students with the concept of habitat.

Procedure

1. List the following words on a chalkboard: food, water, shelter, space. Food and water are easy concepts for the students to understand. Shelter and space are more difficult. Ask the students to explain what shelter and space are, and make sure the meaning of all four words are clear before you proceed.
2. Give the students drawing paper and crayons. Ask the students to draw a picture of where they live, including pictures of where they find food, water, shelter and space. Have them label the parts of their drawings to show where they find their food, water, shelter, and space.
3. Once the drawings are complete, write two more words on the chalkboard: arrangement, habitat. Tell the students that when food, water, shelter, and space go together in a special way so that animals, including people, can live, we call that place a habitat. The food, water, shelter, and space are in an arrangement that makes it possible for animals to live. Ask the students if they could live in a home where the bathroom was four miles north, the kitchen was 12 miles west, and the bedroom was nine miles east! Some animals, however, do travel great distances in their habitat. What might some of these animals be?
4. Have students to write the word "habitat" in big letters at the top of their drawing, talking with them about the meaning of habitat. Then give the students another piece of drawing paper. Ask them to think of an animal that lives at Glacier National Park.
6. Now have them draw a picture of their Glacier animal in its habitat-making sure they include food, water, shelter and space in an arrangement that would make it possible for the animal to live. Arrangement should include the type of area the animal lives in, be it forest, stream, mountains, meadows, or any combination.
7. Again have students write "habitat" in big letters on the top of their drawing and talk about the drawings and the habitat components they have included. Discuss how humans and other animals need food, water, shelter and space. The arrangement is different for each, but all have similar basic needs. Discuss the various arrangements in the students drawings.

Evaluation

Ask the students to write a sentence or two defining habitat on the back of their drawing.

Beaver Succession Mural

Vocabulary

Succession, habitat, change, community, meadows, pond, forest.

Method

Students create a mural showing three major stages of beaver caused succession.

Objectives

- Discuss the concept of succession;
- Describe beaver pond succession as one example of the process of change in natural environments.
- Apply understanding of the concept of succession by drawing a mural showing stages of beaver pond succession.

Background

Succession is a term used to describe the ever changing environment and the gradual process by which one habitat is replaced by another. Many habitats that appear to be stable are changing before us, perhaps at a slow rate in human eyes, but rather quickly according to Earth's clock. Beavers make changes in the environment when they cut trees and build dams. Refer to the "Beaver Natural History" for a synopsis of beaver caused succession from forest to pond, to meadow, and back to forest.

Procedure

1. Discuss with the students the idea of succession: the orderly, gradual and continual replacement of one community of plants and animals with another. Ask students to describe different plant and/or animal communities in your area, making sure the idea of community is clear before you proceed.
2. Explain to the students that they will be constructing a mural showing the gradual changes that take place when a beaver chooses a spot to build his dam.
3. Conduct an informative discussion on beavers. Why do beavers construct dams? How do beavers build their dams? What kind of a habitat do they require?
4. Write the word HABITAT on the chalkboard. Ask the students to name the habitat the beaver requires (encourage students to think of Glacier as a forest habitat as opposed to a woodland habitat) and write FOREST under the HABITAT heading. Ask students what types of plants and animals live in a forest and write appropriate student responses on chalkboard under FOREST.
5. Continue beaver discussion with more questions. What is a result of the beavers dam? What happens to the flooded trees? What new habitat is created as a result of the dam? Write the word POND under the HABITAT heading and ask the students what types of plants and animals are attracted to a pond habitat, listing appropriate responses on the board.
6. How long do the beavers remain at their dam sight? Why do they move on? What happens to the dam after the beavers leave? Ask the students what kind of habitat replaces the pond

Materials:

- * Long piece of drawing paper for mural
- * Construction paper for cut-outs
- * Crayons, paint, scissors

as a result of the beavers departure. Write the word MEADOW under the HABITAT heading and ask the students what types of plants and animals are attracted to a meadow habitat, listing responses on the board.

7. Discuss the process by which the meadow eventually returns to its original state as a forest.

8. Divide the class into three groups and assign each group one of the three habitats listed on the board, placing extra students in the forest group. Mark the mural paper into four segments. The first and fourth segment will be assigned to the forest group, the second segment to the pond group, and the third segment to the meadow group. You may wish to begin by having the whole class work together to construct a stream running along the course of the paper, to be later modified by the pond and meadow groups.

9. Instruct the students to create their assigned habitat by drawing, painting, cut-outs, etc. They may need to work with other groups to coordinate the changing environment to portray a smooth transition as the environment changes.

10. When the mural is completed (and this may take several class periods), ask each group to sign their segment, and then present and explain their segment to the rest of the class. Begin and end with the forest group.

Evaluation

Ask the students to summarize what they have learned, including how succession is one example of the ongoing process of change in natural environments. Obtain a class consensus on how many years the students believe the process of beaver succession from forest to pond, to meadow, and back to forest, will take.

Variation

After students have been divided into groups, have each group research their habitat and the plant and animal life found there, reporting back to the class and making additions and/or corrections to the list on the chalkboard.



Tree Parts

Vocabulary

Roots, stems, leaves, cambium, trunk, heartwood, bark, sap, deciduous, sapwood, phloem, xylem.

Method

Class discussion of tree parts and their functions, then students construct small trees incorporating all the parts it will need to live.

Materials:

- * Cross sections of tree trunks (photos are available from the Internet)
- * Tacks
- * Cardboard tubes (such as empty paper towel tubes)
- * Tape, construction paper, glue, scissors, crayons, paints, pipe cleaners, string, natural plant parts (leaves, twigs, etc.)

Objective:

Students will be able to identify the basic parts of trees and understand how they help the tree to live and grow.

Background:

The purpose of this activity is to familiarize students with the basic workings of a tree.

Procedure

1. Discuss tree parts with students, drawing a tree and a cross section of a tree trunk on the board, labeling the parts and discussing their function. (See “Tree Parts Natural History” below)
2. Erase the cross section drawing leaving a list of the cross section parts on the board. Divide students into groups according to the number of trunk cross sections you have. Give each group a trunk cross section and small strips of paper and tacks with which to label the parts on their trunk. Direct the groups to discuss the function of each part they label.
3. Call on each group to show a tree part on their trunk and explain its function.
4. Distribute tree making materials and instruct students to construct their own small tree, including all of the parts it will need to live.

Evaluation

When the projects are done, have the students share their trees and describe them to the class. Ask them to point out how the sap flows from the leaves and roots to the rest of the tree, and where the tree’s food is made from sunlight. Which parts of the tree are alive? Where is the dead heartwood found? How is their homemade tree different from a living tree?

Tree Parts Natural History

Roots hold the tree in the ground. They branch underground and eventually form into small rootlets with miles of fine root hairs that take up water and minerals from the soil and bring it up to the tree for use. A fully grown deciduous tree can pull one ton of water from the soil each day, about the amount of water it would take to fill the bed of a standard size pickup truck. There is also great power in a growing root. A root four inches around and three feet long can lift the equivalent of 7 elephants stacked on top of each other!

- Leaves (broad leaves and needles) use sunlight to begin the process of photosynthesis, a reaction which takes place in the green chlorophyll of the leaf: water and carbon dioxide, a poisonous gas for humans, are changed into food for the tree (sugar, protein and starch), and oxygen is released for us to breathe. In one year an average tree inhales 26 pounds of carbon dioxide - the amount emitted by an automobile during an 11,300 mile trip (or almost two trips from San Francisco to New York and back again), and exhales enough oxygen to keep a family of four breathing for a year.
- Trunks provide support and act as pipelines to carry water and minerals up to the leaves and branches, and sugar, protein and starch down from the leaves to branches and roots. The following are all trunk parts, moving from the outside to the inside. Bark covers the trunk and branches and protects the tree from disease, fire, and injury. Inner bark or phloem carries sap down from the leaves to the branches, trunk and roots.
- Cambium is a layer that is about two cells thick. Each year it grows new phloem to the outside and sapwood (xylem) to the inside. Branches, trunks and roots grow in thickness as a result of cambium growth. Sapwood and heartwood make up the bulk of the tree trunk. Just inside the cambium is the sapwood, which carries minerals and water up from the roots to the rest of the tree. Some vessels in the sapwood can move stored water and nutrients horizontally to other parts of the tree. Beyond the sapwood is the heartwood, the older, dead sapwood that is usually darker and can no longer carry minerals and water up from the roots. It now provides support for the tree. Being dead, heartwood can rot away to leave a hollow tree with a covering of living wood on the outside.



Old Growth Forest Mural

Vocabulary

Old growth, forest, community, diversity, saplings, snags.

Method

Students create a mural of an old growth forest.

Objectives (Students will be able to)

- Identify the four components of an old growth forest;
- Apply understanding of the forest community and its residents.

Background

The purpose of this activity is to allow students the opportunity to examine the diversity of life that makes up an old growth forest community.

Procedure

1. Discuss a forest community with the students, and the four characteristics of an old growth forest. (See the background information on “What is an Old Growth Forest?”)
2. Explain to the students that they will be constructing a mural of an old growth forest, and divide the students into four groups, assigning each group to one of the four characteristics of an old growth forest. Each group will be responsible for portraying their part of the forest and the community of organisms which thrive there. For example, the group assigned to large living trees and a multi-layered canopy, will want to place many living trees on the mural; tall, old living trees and younger trees and saplings. They will also want to find out what types of animals depend on these trees for food, shelter and nesting, and represent them on the mural.
3. Have the groups research old growth forests, looking for organisms that inhabit the particular niche they’ve been assigned to.
4. After students have gathered the material they need, they may begin drawing, painting, and making cut-outs for the mural. You may wish to make an outline for the mural to insure that the forest mural is equally distributed with living trees, snags, down trees, and a stream running through the forest, so that there are not clumps of snags, etc., on the mural, from one group placing their material all in one spot.
5. When the mural is completed (and this may take several class periods), ask each group to present and explain their part of the forest and the organisms living there to the rest of the class.

Evaluation

Ask the students, “Why are old growth forests important?” Discuss with the students the present rate at which we are harvesting our forests, and that today only 10% of the world’s remaining forests are old growth forests. “Would it matter if we continued to harvest the trees in what is left of our old growth forests?”

Materials:

- * Butcher paper for mural
- * Construction paper for cut-outs
- * Crayons, paint, scissors, glue.

Eco-enrichers

Vocabulary

Ecosystem, soil, nutrients, fertility, acidity, alkalinity, porosity, organic, compost, control.

Method

Students experiment with soil and earthworms.

Materials:

- * Soil from the same source to fill three 1" x 1" x 1" containers
- * Earthworms
- * Composting material (like kitchen scraps and yard leaves).

Objectives

Students will be able to evaluate the importance of plant and animal matter as contributors to soil.

Background

Wildlife is an important contributor to healthy ecosystems. The major purpose of this activity is for students to recognize one example of the kinds of significant contributions from wildlife. In this case, earthworms (not always recognized as wildlife) enrich a growing medium, soil.

Procedure

1. Select some soil that is not particularly rich. It might be heavily compacted- by a roadside; or in an area where there has been a lot of erosion. Note, however, that soil may look infertile but be rich with inorganic nutrients. Take a large enough sample of the soil to fill three 1' x 1' x 1' containers. With your students, do simple soil tests to determine the quality of the soil. For example:
 - a. Look for signs of plant or animal matter in the soil. Count the number of species you can identify; examine a sample under a microscope; count the number of organisms in the sample; estimate the number of organisms in the entire quantity of soil in the container based on the number of the sample.
 - b. Test acidity and alkalinity with pH kits.
 - c. Check porosity by determining how fast water will run through each soil sample.
 - d. Conduct a settling test to see what general proportions of soil components are present; i.e., sand, silt, clay, organic matter.
3. After the soil tests have been completed and recorded, it is time to see what contributions at least one form of wildlife can make to the richness of soil. Divide the soil into the three containers. One container is the "control." The second is for soil and compost only. The third is for soil, compost, and earthworms.
4. Begin adding compost materials (plant and animal matter) -like table scraps, grass clippings, leaves, etc. to the second and third containers. Add earthworms to the third container. Occasionally water the soil lightly-to simulate a rainstorm. You can also lightly water the first box-but do nothing else to the first box of soil. NOTE: You can begin with a larger number of earthworms if your soil box is large, and if you want to speed up the process.
5. Since the worms are in a limited environment you and the students will need to keep adding the food and other compost materials. Compost may be added to the second container, also. Plan on adding materials once a week for three weeks, and watering lightly once a week.

Encourage the students to watch for changes in any of the boxes. An observation sheet can be attached to the outside of each box for the students reporting purposes.

6. At the end of the three-week period conduct the same set of experiments you originally conducted with the soil. Conduct the tests with all three boxes. In testing the soil in the earthworm box, make sure the students take care not to harm the earthworms; many may die anyway. Be prepared for this possibility, and add additional earthworms as necessary.

7. Discuss the findings. What differences are there in the three soil samples?

8. Now plant some seeds in all three of the soil boxes. Pick a fast-growing seed, like radishes. Seeds from plants native to the area might be available as well. Plant the same number of seeds in each of the soil boxes. Record the date of planting. Record all watering procedures and changes in the boxes as the plants begin to grow. After three weeks, compare and discuss the results. Describe the importance of plant and animal matter as contributors to soil. Talk about earthworms as one example of the role of wildlife in contributing to healthy environments

Evaluation

List three ways that earthworms have a positive effect on soil. Name three other types of wildlife, and describe briefly how each contributes to improving or maintaining soil.

Decomposing log
stages



Forest Poems

Vocabulary

Haiku, cinquain.

Method

Students share their observations about the forest in a group activity, then go off by themselves and write a poem.

Materials:

- * Pencils
- * 5x7 index cards, one for each student
- * Laminated sheet with an example of a haiku and cinquain poem

Objectives

1. Share highlights of their forest experience with their classmates;
2. Express their observations and feelings about the forest in a poem.

Background

The purpose of this activity is for students to experience nature as the inspiration for a poem, and to successfully write the poem.

Procedure

1. Ask the students to sit down in a circle. The first person begins by telling something they observed, felt, or did in the forest: "I saw a beetle boring into the wood of a fallen tree," or "I liked the fresh smell of pine needles in the forest." What was it like? What did it remind you of?
2. The next person does the same, and then repeats the statement of the first player. This continues all the way around the circle, until the last player is left to repeat the statements of everyone in the circle. Depending on the size of the class, you may want to divide into two or three circles, so that it is not impossible to repeat all player's statements.
3. Begin a discussion about poetry with the entire class, asking the students what a poem means to them. Students have a tendency to get "freaked-out" over the thought of writing a poem, thus the discussion can aid in breaking down a poem into the concept of a grouping of words designed to relate a vivid and imaginative sense of experience. Encourage the students to use an abundance of descriptive words. Their goal is to try to bring the experience of the forest alive through their creative use of words. Have them think how they would answer the questions: What was it like? What did it remind you of?
4. Give the students suggestions of the types of poems they might create: rhyming poems, a poem in the shape of a tree, a haiku or cinquain (have an example of these types of poems for the students).
5. Point out a large area with boundary marks, and instruct the students to find their own special spot, a spot they feel attracted to. Have them put their paper and pencil down, and for the first five minutes, sit absolutely still, letting the world around them go on as it does when they aren't there. Direct them to feel that they are a part of the natural surrounding; mentally move with the pine needles as the wind whisks by, or hop along the forest floor with a robin searching for food. At your signal, they may begin their poem. Allow 10-20 minutes for poem writing, then call the students back for evaluation discussion.

Evaluation

Ask the students about their poem experience. “Does anyone want to share their poem?” (You may want to loosen up the group by sharing yours first!) “If you had to choose between two comfortable, safe places to live, one with and one without a forest, which would you choose? Why?”

Haiku

Haiku, originated by the Japanese, consists of three lines of five, seven and five syllables each. The emphasis is syllabic, not rhyming.

For example:

The students explored
giant green pillars of life
dwarfed by their glory

Cinquain (sounds like “singkane”)

This is another form of poetry based on syllables and derived from the French and Spanish words for five. There are five lines, and each line has a purpose and number of syllables:

1. The title in two syllables (or two words)
2. A description of the title in four syllables (or words)
3. A description of action in six syllables (or words)
4. A description of a feeling in eight syllables (or words)
5. Another word for the title in two syllables (or words)

For example:

Hiking
Walking along
Breathing crisp, quiet, clean air
One with nature’s wonderful ways
Sharing

Meet a Tree

Vocabulary

Bark, texture, observations.

Method

Blindfolded pairs of students take turns exploring a tree.

Objective

Students will be able to experience the forest as a collection of individual trees by making observations of one tree while blind-folded.

Background

The purpose of this activity is to allow students an opportunity to use their senses to make observations of a tree.

Procedure

1. Students pair off, one student being blindfolded and the other carefully leading the blindfolded student through the forest to any tree that attracts him. Instruct leaders to tell their partners when to lift their feet to step over a log, when they need to duck to avoid branches, etc. Identify a boundary so students do not disappear in the forest!
2. The leader instructs the blind foldee to explore his tree and feel its uniqueness - without removing the blindfold! Instruct leaders to be specific: "Is this tree alive? Feel the bark with your cheek. How does the tree smell? Can you put your arms around it? Are there any plants growing on the tree? Animal signs? How does the ground around your tree feel? How old is the tree?"
3. After the "blindfoldee" is done exploring his tree, the leader leads him back to the starting point, taking a roundabout way to further challenge the blindfolded student. Remove the blindfold and let the student try to find the tree with his eyes open. The leader can help by responding "yes" or "no" to the other student's choices.
4. When the correct tree is found, students change places and the leader becomes the "blind foldee."

Evaluation

"Do you think you can find your tree if you returned to this forest next month? Next year?"
How has your perception of the forest changed?

Materials:

* Enough blindfolds for half the number of students in the class.

Meeting the Fire Triangle

(from the USFS FireWorks Curriculum)

Vocabulary

Fire Triangle, fuel, heat, oxygen, triangle

Materials:

- * Gumdrops (12+ per student team)
- * Toothpicks (12 per student team)

Method

In this activity, students make a physical model of the Fire Triangle as a geometric shape. They manipulate the model and discuss the components of the Fire Triangle in the context of things they are already familiar with—candle flames, campfires, and engines.

Objective

Given toothpicks and gumdrops, students can construct a geometric triangle, name the components of the Fire Triangle, and explain that removal of one component of the Fire Triangle extinguishes the fire.

Background

Fire can occur only if oxygen, fuel, and heat are available. These three components are called the “fire triangle.” The complete curriculum this activity is from is online at http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf. The educational FireWorks trunk and materials that go with this curriculum are available from the Glacier Education Specialist.

Procedure

1. Explain that fire has occurred in forest communities for hundreds of years. To understand more about fire in nature, they will first learn more about fire itself.
 2. Ask students to work in groups of three or four.
 3. Explain: Each student team should build three or four shapes out of gumdrops and toothpicks. Write them on the board: 3-sided (triangle), 4-sided (in this case, a square), 5-sided (pentagon), and 6-sided (hexagon). Use the toothpicks for the sides and gumdrops for the corners.
 4. Ask students to find out which shape is the most “stable” one, that is, it keeps its shape even when you push on a side or a corner. Unless they eat all the gumdrops, it won’t take long for them to decide that the triangle is the most stable.
 5. All students can convert their shapes to triangles. Ask students what happens when one leg of a triangle is removed. It collapses into a single line.
 6. Explain: Scientists use the idea of a “triangle” to describe fires because a fire needs three things to be stable, that is, to keep burning. Can they think of what is needed? List their thoughts on the board. Look for items relating to ignition sources, fuel, and oxygen.
 7. Display the Fire Triangle image. Explain that these are the three things needed to start a fire and keep it going, and relate the components on the triangle to students’ ideas on the board.
 8. Ask what happens when one of these components is removed from a fire. (It stops burning.) Ask: Burnable things surround us every day. Why aren’t they on fire? (An external source of heat is usually needed to start a fire. Once a fire has started, it produces the heat needed to continue burning. A fire can be put out if fuel, oxygen, or heat is removed.)
-

9. Ask how people can use this knowledge to stop a fire that occurs in their homes and in wildlands. (When you throw water on a fire, you cut off oxygen and remove heat. You can also cut off oxygen by throwing dirt on a fire. “Stop, drop, and roll” reduces the supply of oxygen to a fire. Running away would do the opposite—add more oxygen—so it is a bad idea. Fire extinguishers remove heat and deprive a fire of oxygen. Fire retardant dropped from airplanes removes heat and cuts off oxygen from wildland fires. When all the wax is gone from a candle or all the fuel is burned in a campfire, it goes out.)

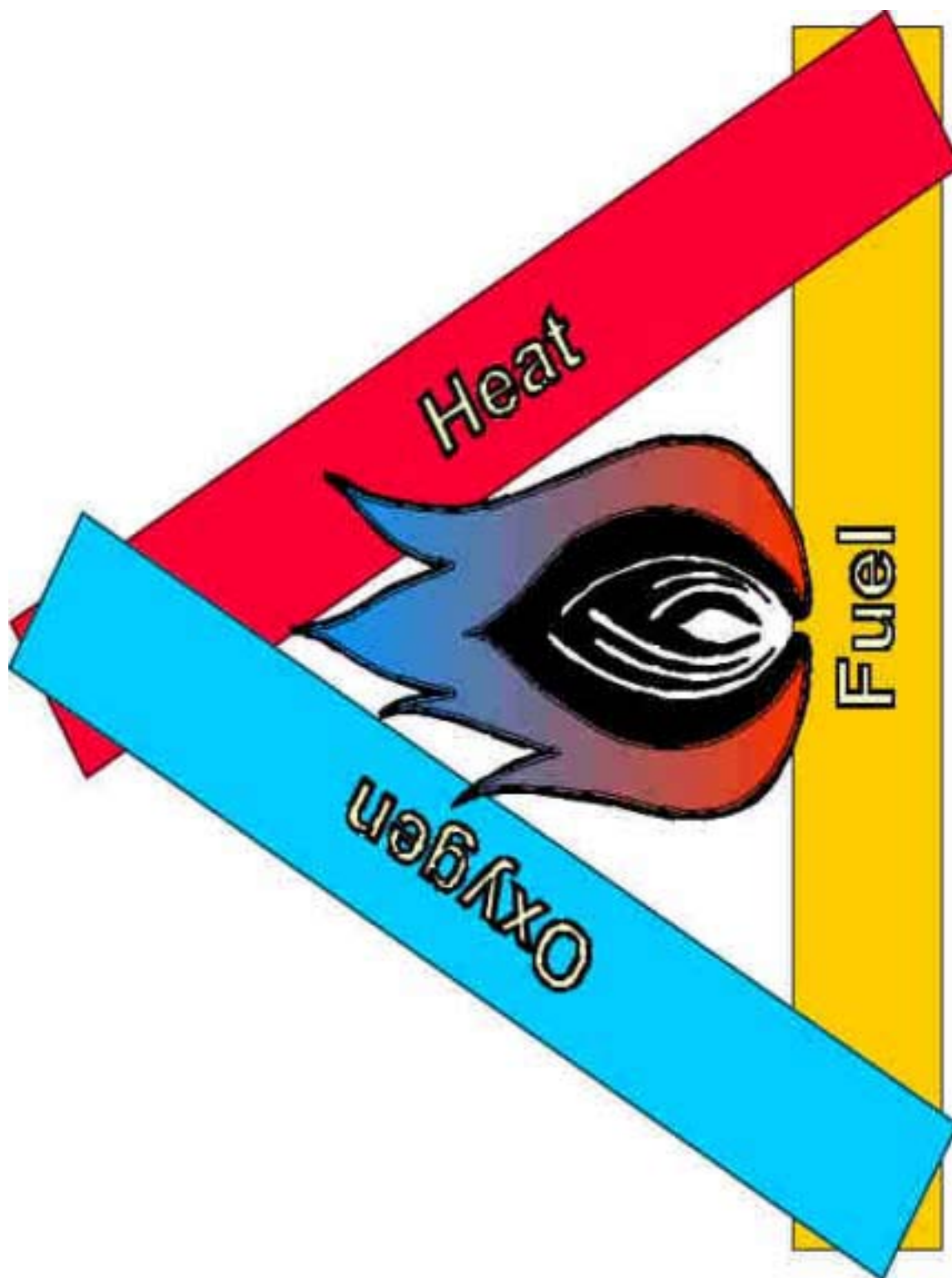
Evaluation

1. Name the three things needed for a fire to occur.
2. Explain to a partner and demonstrate how “stop, drop, and roll” removes something from the Fire Triangle and puts a fire out.
3. Closure: Collapse the triangles completely by eating the gumdrops and throwing the toothpicks away.

Extensions

1. Make and decorate your own paper fire triangles.
 2. Read about people’s feelings about fire in Legends of Earth, Air, Fire and Water. These stories would be fun to read to the whole class.
-

The Fire Triangle



Meeting the Fire Triangle 2

(from the USFS FireWorks Curriculum)

Materials:

- * Tree poster/picture
- * Transparency of Fire Triangle
- * Discussion questions

Vocabulary

Fire Triangle, fuel, heat, hypothesis, model, oxygen, prescribed fire, tree crown

Method

This activity is a brief guided discussion that describes combustion and wildland fire.

Objective

Given materials for a paper model, students can construct a model of the Fire Triangle and explain how extinguishing a fire is analogous to removing one leg of a triangle.

Background

Fire can occur only if oxygen, fuel, and heat are available. These three components are called the “fire triangle.” The complete curriculum this activity is from is online at http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf. The educational FireWorks trunk and materials that go with this curriculum are available from the Glacier Education Specialist.

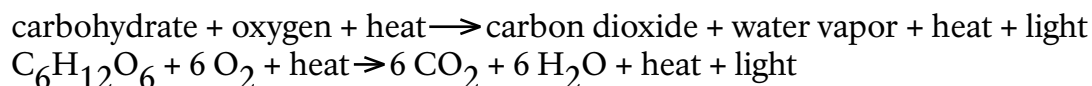
Procedure

1. Post or draw the Fire Triangle picture in the classroom. Ask students what is needed for a fire. Write answers on the board. Then use the answers to discuss the three parts of the Fire Triangle: heat, fuel, and oxygen. The Fire Triangle transparency can be used as a transparency to guide discussion, but may not be necessary.
2. At the end of the discussion, ask students to construct a paper model of the Fire Triangle Kit (student page 2); use this as an evaluative tool.

Discussion Points

1. **What is fire?** Fire is a rapid chemical reaction that combines fuel and oxygen to produce heat and light.

INFO SPARK—Integrating with physical science: You can use either of the formulas below to describe the chemical reaction for combustion. Information about photosynthesis and respiration or the oxygen and carbon cycles, presented in many science texts, can also be used here.



2. **Burnable things surround us every day. Why aren't they on fire?** An external source of heat is usually needed to start combustion. Once a fire has started, it produces the heat needed to continue burning. A fire can be put out if fuel, oxygen, or heat is removed. This idea is often depicted using a triangle (refer to the Fire Triangle poster). Remove any one of the three legs of a triangle, and it will collapse; remove any one of the required components of fire, and it will go out.

3. What is the fuel in fires we are familiar with? Most cars are fueled by gasoline, using an “internal combustion” engine; candles are fueled by melted wax, furnaces by natural gas or fuel oil, and campfires by wood.

4. What fuels a wildland fire? In nature, fire’s fuel is plant material. Use a tree picture to discuss nature’s fuels and illustrate these points:

- Tree crowns, high above the ground, provide some fuel; these include tree branches, leaves (needles are a kind of leaf), and trunks.
- Fuels that lie on or right above the surface of the ground include dead and fallen needles, eaves, grass, dead wood, stumps, and low shrubs.
- The main ground fuel is duff, the layer of dead, decaying plant material that makes up the top layer of soil. It contains decaying leaves, decaying wood, and roots. Sometimes it is mixed with mineral soil (very fine rock particles), which won’t burn.

5. Where does the oxygen for fire come from? Oxygen is plentiful in air. Students may be able to relate the “oxygen” part of the fire triangle to their fire-safety education: “Stop, drop, and roll” is one way to reduce the oxygen available to burning clothing. If a person runs with clothing on fire, the oxygen supply increases and the fire burns more intensely.

INFO SPARK—Integrating with Life Science, Mathematics, and Physical Science: Oxygen comprises about 21 percent of the air we breathe. Nitrogen gas comprises 78%. Argon, carbon dioxide, and other gases comprise the remaining 1%. Oxygen is so plentiful that we use only about 20% of the oxygen in every breath we take. If we used it all, artificial resuscitation couldn’t work! Students can make a pie chart showing the chemical composition of air. This discussion point also provides an opportunity to refer to the oxygen and carbon cycles, photosynthesis, and respiration.

6. What heat sources do we use to start fires? Spark plugs in cars, pilot lights in appliances, and matches are some examples.

7. What provides heat for forest fires? In wildlands, nature provides heat in lightning and volcanoes. Matches, untended campfires, and cigarettes are the sources of heat for many human-caused wildland fires. During the thousands of years when Native Americans were the only people living in North America, they often started fires to change the plant communities that provided their food and shelter. They used fire to make their campgrounds safe from fire and enemies, to improve grazing and berry supplies, and for many other reasons. After they obtained horses, Native Americans used fire to improve forage for their herds. Today, we would call these prescribed fires.

8. How does wind influence fire? Wind influences fire in many ways. Think about starting a campfire. If you blow on it, you provide extra oxygen and blow the heat toward the fuels, getting the fire to burn more intensely. If you blow too hard, especially across a small flame like a candle, you scatter the heat so much that the fire goes out. Wind helps forest fires spread by drying out fuels and carrying burning embers ahead of the fire.

9. Use the fire triangle to describe some ways to put out a fire. To slow down a fire or put it out, at least one of the three components of the fire triangle must be changed. Think about ways that both large and small fires are controlled. When all the wax is gone from a candle or all the fuel is burned in a campfire, it goes out. A fireline, used to control forest fires, is simply a path

cut through all of a forest's fuels—down to mineral soil. When the fire gets to the fireline, it runs out of fuel. When you throw water on a fire, you cut off oxygen and remove heat. You can also cut off oxygen by throwing dirt on a fire. Fire extinguishers and fire retardant dropped from airplanes remove heat and cut off oxygen from wildland fires.

Evaluation

Provide each student with a Fire Triangle Kit. Ask students to construct a Fire Triangle and label the parts correctly. Ask them to write a paragraph in which they do the following:

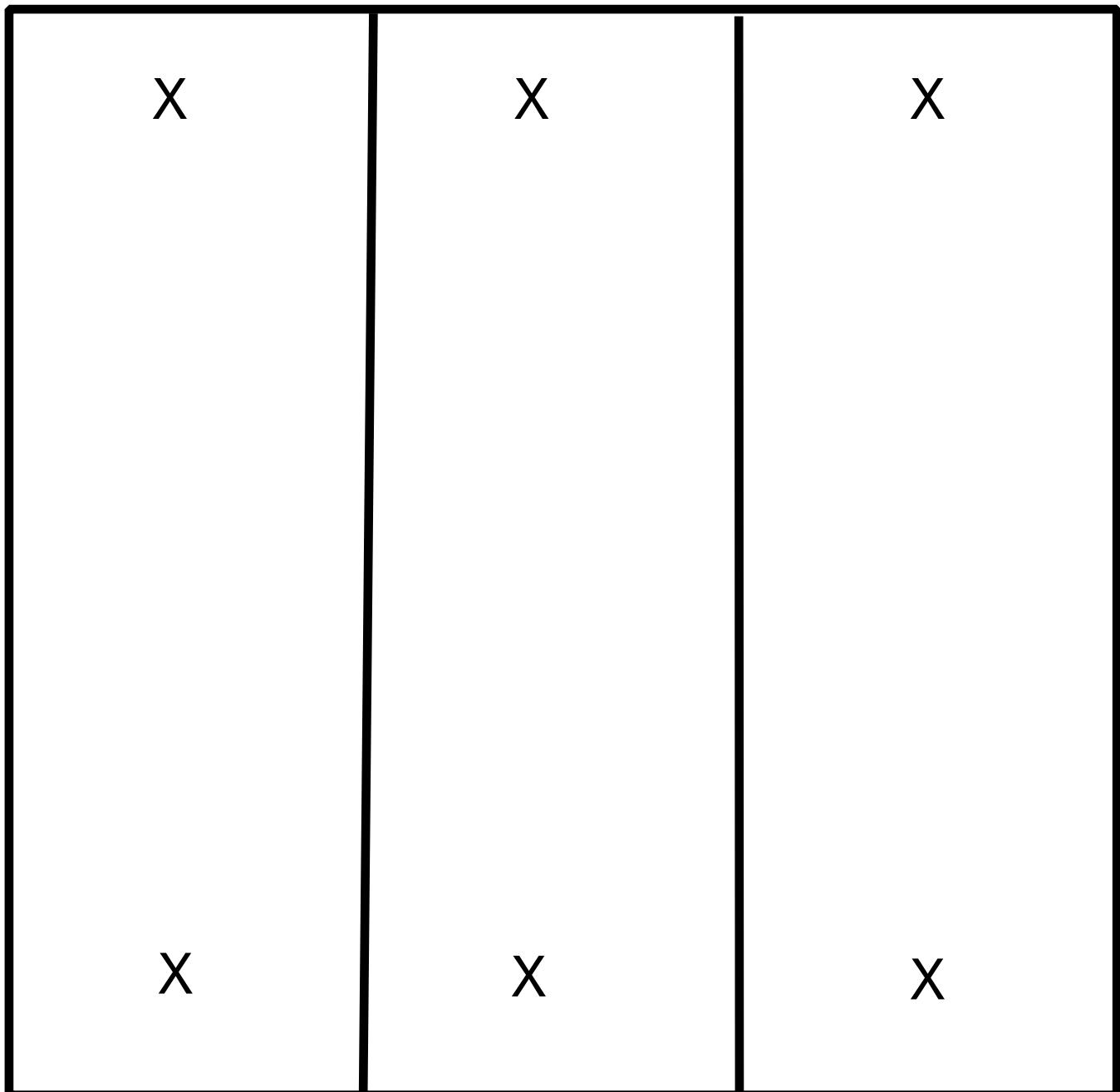
1. Describe a fire (candle, engine, campfire, and forest fire are all possibilities)
2. Tell one way to put it out
3. Explain what part of the Fire Triangle is removed when that method is used to put it out
4. Explain to students that this discussion has provided a model for how fires work. A model is like an hypothesis because it is an explanation for something observable, and it can be tested.

Extensions

1. Make a collage of familiar things that use combustion. Examples: Cars and gas appliances contain “burning chambers.” Electrical appliances may rely on combustion of coal to produce power. Barbecues, lanterns, and candles use fire. So do “real” fireworks displays. Use the components of the Fire Triangle to describe how combustion is controlled in these items.

Fire Triangle Kit

1. Cut along the lines to make the three "legs" of your Fire triangle.
 2. Mark one leg "Fuel." Mark another "Oxygen." Mark another "Heat."
- Decorate the pieces.
3. Punch holes on the X marks at the ends of each leg.
 4. Put brads or other connectors through the holes and connect the legs of the triangle. Write your name on the back.
 5. If you remove one leg of a paper triangle, what happens to it?
 6. If you remove one leg of the Fire Triangle, what happens to the fire?



Predicting the Future

Materials:

* Paper and pen

Vocabulary

Probability, model, prediction.

Methods

Students are asked to make their own predictions on what they will be doing one week from now, one year from now, and one decade from now.

Objectives

-Identify the process by which scientists at Glacier are determining/predicting the short and long range effects of global climate change.

Background

Scientists who are working on the global climate change issue are basically trying to predict the future. What will happen to Earth's climate if the greenhouse gases in the atmosphere are increased at a rapid rate? They are trying to make accurate regional as well as global predictions. Scientists at Glacier National Park have chosen to work with a complex computer generated model to help them make these predictions. The accuracy of this type of model is dependent upon the extent and quality of the data that is fed to the computer. The students will gain an understanding of the difficulties inherent in this method of prediction as they attempt to collect data for their own predictions.

Procedures

1. Ask the students what they know about predicting the future. Have they ever tried it themselves? Do they read their daily horoscope? Do they ask their parents? How about the psychic predictions in the National Enquirer? What do they think of those? If they think that the Psychic's predictions are unlikely to happen, ask them what data they are basing this belief upon.
2. Discuss the concept of probability. Scientists at Glacier National Park use this concept to organize the computer generated climate model which will help them to predict future weather patterns and their effect on the life forms living in the park.
3. Tell the students that they will be making their own attempt to predict the future by describing what they will be doing one week from today, one year from today, and one decade from today. Have them draw up a chart with three sections, one section for each prediction.
4. Have them start by collecting as much data as possible for each phase of their prediction. They can gather data from you on next week's lesson plans, from their parents on any future family plans that are known or under consideration, from the almanac or the weather station on conditions such as storms that might cause a change in plans. Encourage them to be thorough in their data collecting process-separating what is known from what is guessed and with the guesses have them rate the likelihood (probability).
5. When they feel that they have collected as much data as is available, have them write up their predictions. When it is time to share their predictions with the class they might enjoy creating an atmosphere by dressing up as fortune tellers or setting up mock computer charts to use as props.

Evaluation

How confident do the students feel about their predictions? The further into the future that the prediction is aimed, the more difficult it is to obtain accurate data. Scientists are trying to look ahead 50 and 100 years. What do the students think of their chances? The other difficulty that arises is-do you act on a prediction or do you wait until you know for certain what is happening? What if you wait until you are certain before you take action to correct a problem and then find that you are too late? What if you take immediate action on the strength of a prediction and later find out that the prediction was not accurate? It becomes a question of risk taking-playing a hunch, or not.

“It’s most important that the students understand the range of possible consequences so they can choose how they wish to take risks with their own planet.”

Stephen Schneider

Puzzle It Out

Vocabulary

Climate system, greenhouse effect, interrelationships.

Method

Students draw the various components of the climate system on large construction paper puzzle pieces and then decipher how the pieces fit together.

Objective

Students will be able to identify the components of Earth's climate system.

Background

Earth's climate system is comprised of many individual parts: some of them global, like the ocean with its deep currents or the atmosphere with its greenhouse cycle, and some of them local, like rain, wind, the shade of a forest, or the heat trapping pavement of a city. The scientists who are working on the global climate change issue are trying to understand how all of these various components of the climate system fit together. When they have learned how each piece of the puzzle operates, they will be better able to understand what happens when pieces are changed or shuffled around. It is interesting to find out that scientists are still finding new pieces to this climate puzzle and trying to understand them well enough to fit them into the big picture. Clouds have turned out to be more than just rain bearers and volcanoes have earned a place in the puzzle with their ability to affect the temperature of the planet.

Procedures

1. Cut out enough puzzle pieces made of construction paper to give one to every student. If the class is small, each student could do two pieces. On the back of each piece, write down the name of one component of Earth's climate system. Every piece should be different and your list could include the following: Temperature, light, moisture, wind, snow, ice, desert, forest, rock, clouds, deep ocean currents, plankton, fresh water, salt water, atmosphere, infrared energy, photosynthesis, greenhouse gases, human industries, volcanoes, trees, and plants.
2. Each student receives a puzzle piece and draws a picture of whatever is listed on the back.
3. When all the pictures are drawn, the class comes together to talk about each piece of the puzzle and figure out how they all might fit together. Give each student time to research their piece and then explain it to the class. When all of the pieces have been described, find a large flat area to lay out the pieces and start trying to fit them together.
4. Discuss the fact that several of the pieces of this puzzle can fit together in more than one way. Try several different combinations and ask how each variation changes or doesn't change the big picture. When the students have the puzzle put together to their satisfaction, tack it up on the wall. They may want to make changes to it as they continue with the global climate change unit.

Materials:

- * Construction paper cut into universal puzzle shapes (meaning that all of the pieces will fit into every other piece)
- * Drawing markers, crayons.

Evaluation

Scientists have to be ready to modify their theories on Earth's climate system whenever new data changes the perspective on how pieces fit together. Also, Earth's climate system is dynamic rather than static so it is continually making adaptations and adjustments to situations like the human caused increase of carbon dioxide in the atmosphere. Does all of this mean that your puzzle on the wall can never be "finished"? Does it have to be finished in order for you to feel confident that you understand enough to step in and start manipulating pieces of the puzzle? Can we learn to control Earth's climate system?

Carbon Cycle Capers

Vocabulary

Carbon dioxide, greenhouse gas, molecule, fuel burner, CO₂, carbon cycle.

Materials:

* Enough rags to make armbands for half the group.

Method

This is a fast-moving game of tag which pits the Trees against the CO₂ molecules.

Objective

Students will be able to identify the cyclical relationship between carbon dioxide in the atmosphere and plants on earth which trap and store carbon.

Background

The purpose of this activity is to introduce students to the carbon cycle.

Procedures

1. Review the basic greenhouse gas cycle.
2. Divide the group. One student will be Fuel Burner. The remaining students will be evenly divided-half will be Trees and half will be CO₂ molecules. Choose either group to start wearing the armbands.
3. To start the game, set the boundaries of the playing area and have the Tree and CO₂ teams go to the opposite ends of the playing area. The Fuel Burner waits on the sidelines at the start of the game.

Rules:

- The Trees' objective is to absorb (capture) the CO₂ molecules. They do this by linking arms with the CO₂. Each Tree is allowed to absorb two CO₂ molecules but can only "take" a molecule that has an open arm. When a Tree has captured two molecules, it is "full" and must freeze in place. When the Fuel Burner touches a Tree, the Tree "dies" and releases its CO₂ molecules. "Dead" Trees fall to the ground and stay there until the Fuel Burner plants them.
- The CO₂ molecules' objective is to "hang out" in the atmosphere with each other, basking in the radiated warmth of the Earth. They do this by linking arms with each other. If a CO₂ molecule has both arms linked to other molecules then a tree cannot absorb it.
- The CO₂ molecule that has been absorbed by a Tree must stay with that Tree until it is freed by the Fuel Burner, at which time the molecule goes back to "hanging out" in the atmosphere.
- The Fuel Burner's objective is to tag Trees, thereby cutting them down to burn for energy. The Fuel Burner doesn't enter the game until the Trees and CO₂ molecules have been playing for a few minutes. There is no limit to the number of Trees that the Fuel Burner may tag. The Fuel Burner may also "plant" Trees by returning to a "dead" Tree and helping it to catch and absorb a CO₂ molecule.
- The game is over when you run out of time or Trees or CO₂ molecules.

Evaluation

Discuss the results of the game. How does the game compare to the real carbon cycle in which the oceans play a role in balancing the amounts of carbon dioxide in the atmosphere? Are there any differences in the cycle before and after the Fuel Burner shows up?

Poster Campaign

Vocabulary

Climate change, greenhouse effect.

Method

Students create posters that highlight specific issues of climate change.

Materials:

- * Posterboard
- * Markers, pens, scissors, glue
- * Construction paper
- * Magazines

Objective (students will be able to)

-Share what they've learned about climate change and the greenhouse effect with the rest of the student body.

Background

The students have discovered that the causes and consequences of the green house effect are complex issues that will only be solved by people everywhere on the planet working together. This activity will demonstrate to the students that although the problem seems unwieldy and immense, they can start tackling it simply by spreading the word.

Procedures

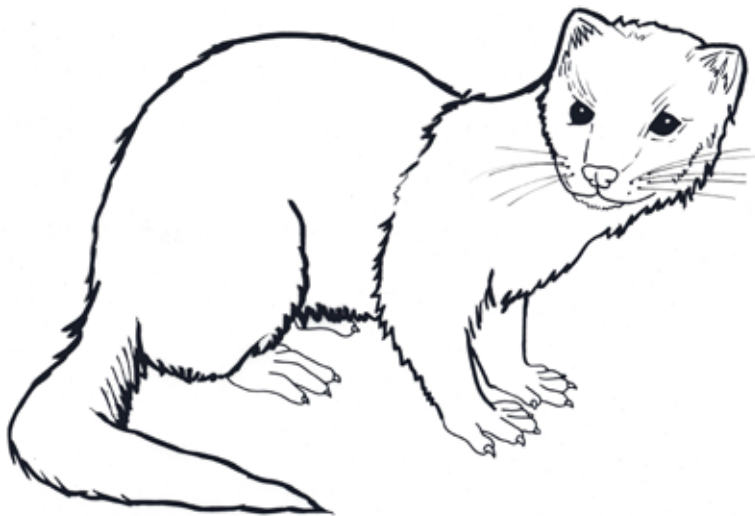
1. Tell the students that they are going to start a poster campaign to share what they've learned about climate change and the greenhouse effect. They are going to tell their fellow students what is happening and what they can do about it.
2. Encourage the students to be bold and creative with their posters to catch the eye and the imagination of the viewer. Have each student select a single aspect of the issue to focus on. One student could show the carbon cycle while a friend's poster shows a way for all of us to reduce our use of coal or gas.
3. When the posters are ready to be hung in prominent places around the school (and in the community), tell the students to be ready to answer questions. They are now the resident experts!

Evaluation

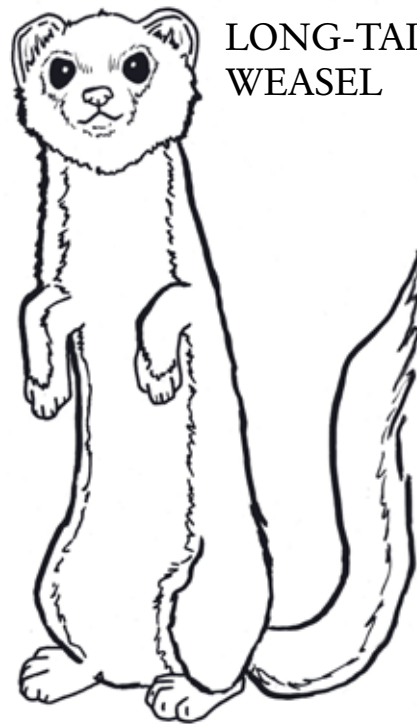
Climate change is a worldwide and long distance issue that is hard for people to "wrap their brain around" and respond to in their everyday existence. It is amazing thought for the students to realize that the gas they burn in getting to school today may cause their grandchildren's world to be hotter and drier. Have them consider the effectiveness of their poster campaign. Are people curious? Have they had any questions? What else could they do right now to help spread the word and get people everywhere interested in working on the problem together?

Extension

Making a Personal Commitment - discuss with students the fact that it is individuals becoming more efficient energy users that will reduce the greenhouse problem and many related problems like acid rain and ozone depletion. One major way to control the greenhouse problem is to reduce fossil fuel emissions. Every individual on this planet has a choice in how they use energy-efficiently and with regard to the future or wastefully. There are numerous books and magazines that describe the various steps that individuals can take to improve their energy efficiency. Challenge students to select one idea that they wish to act upon. Have them design a certificate of personal commitment stating what they have agreed to do this year to help solve the greenhouse problem. It could be planting a tree, writing a report to share with the class, or biking to their friend's home instead of driving.



MINK

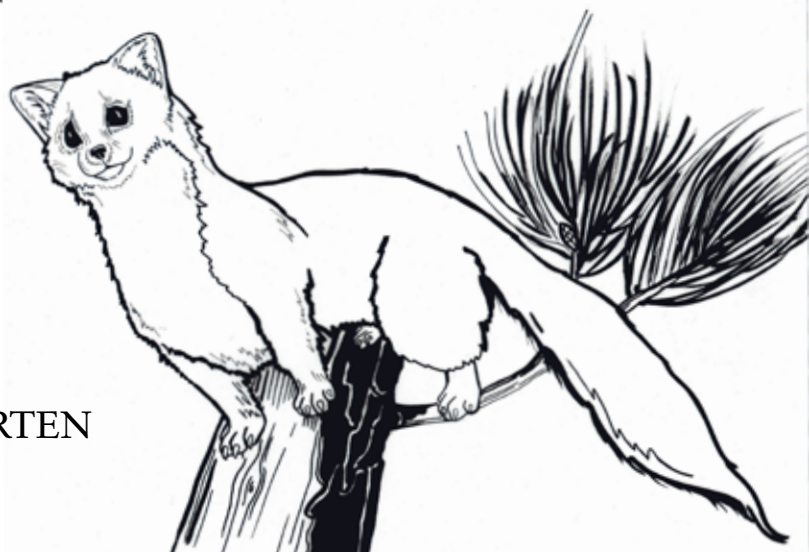


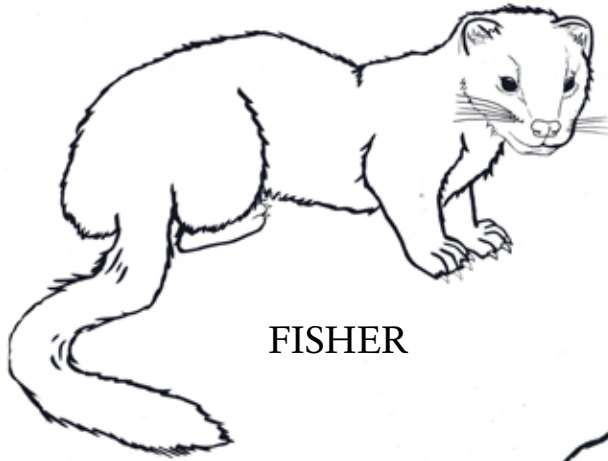
LONG-TAILED
WEASEL

SHORT-TAILED WEASEL
OR ERMINE

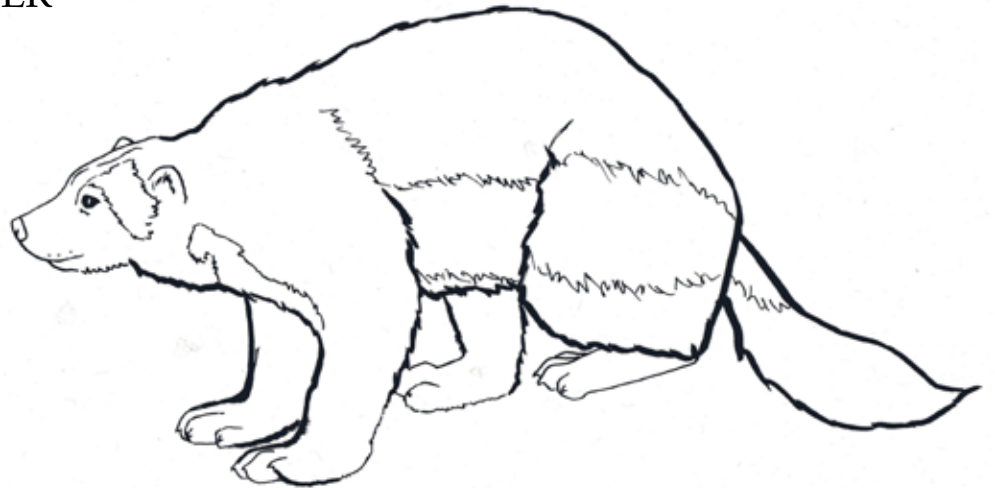


PINE MARTEN

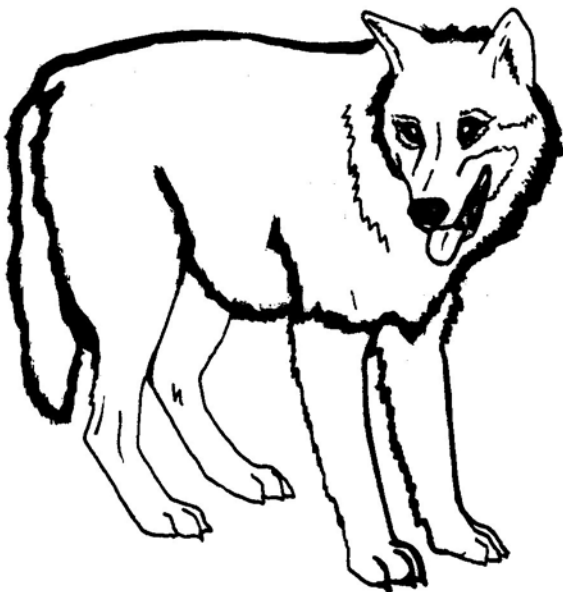




FISHER



WOLVERINE



WOLF



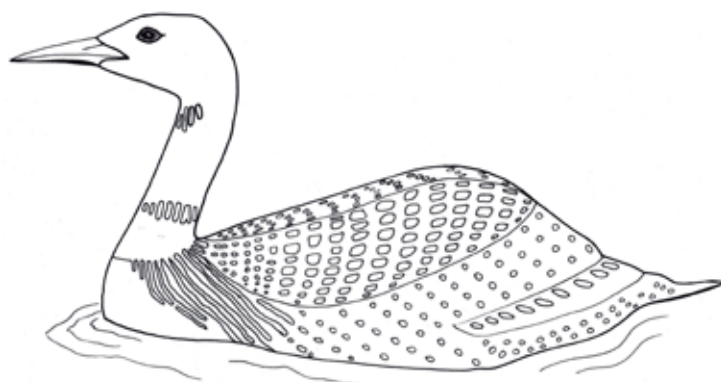
WOODPECKER



MOLE



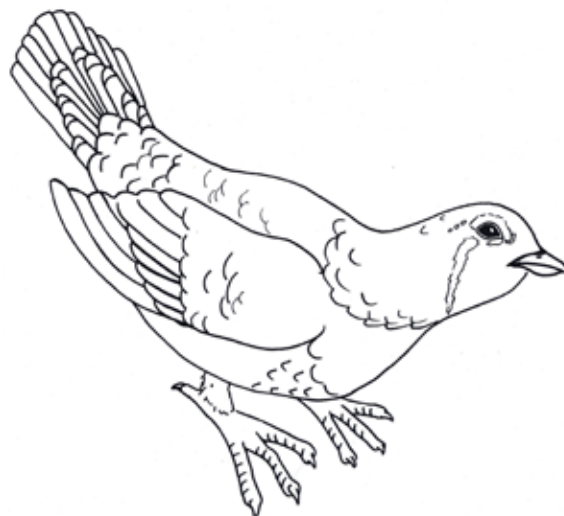
LONG-
EARED BAT



LOON



COLUMBIAN
GROUND SQUIRREL



SPRUCE GROUSE



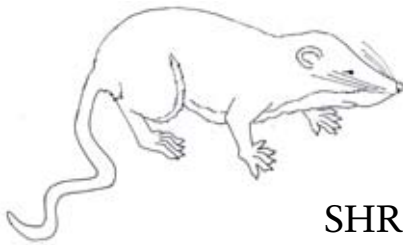
MEADOW VOLE



CLARK'S
NUTCRACKER



MOUSE



SHREW



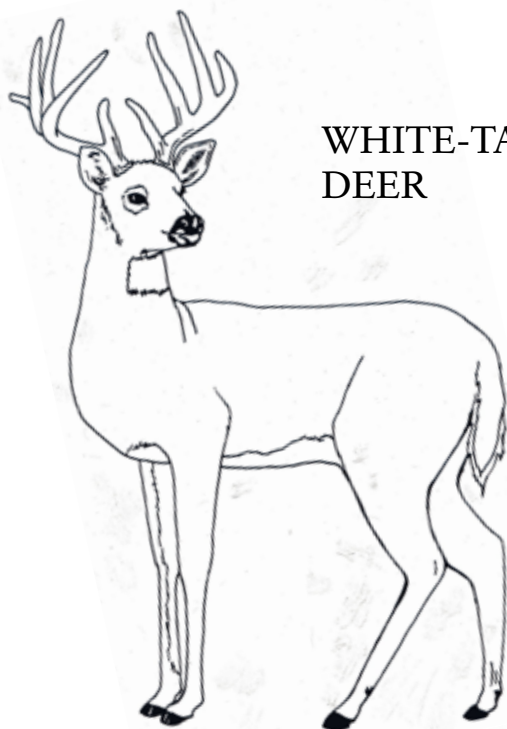
MOUNTAIN GOAT



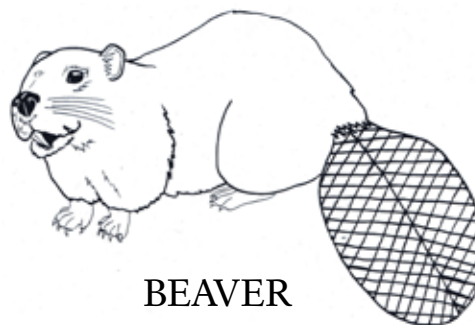
GOLDEN-MANTLED
GROUND SQUIRREL



POCKET GOPHER



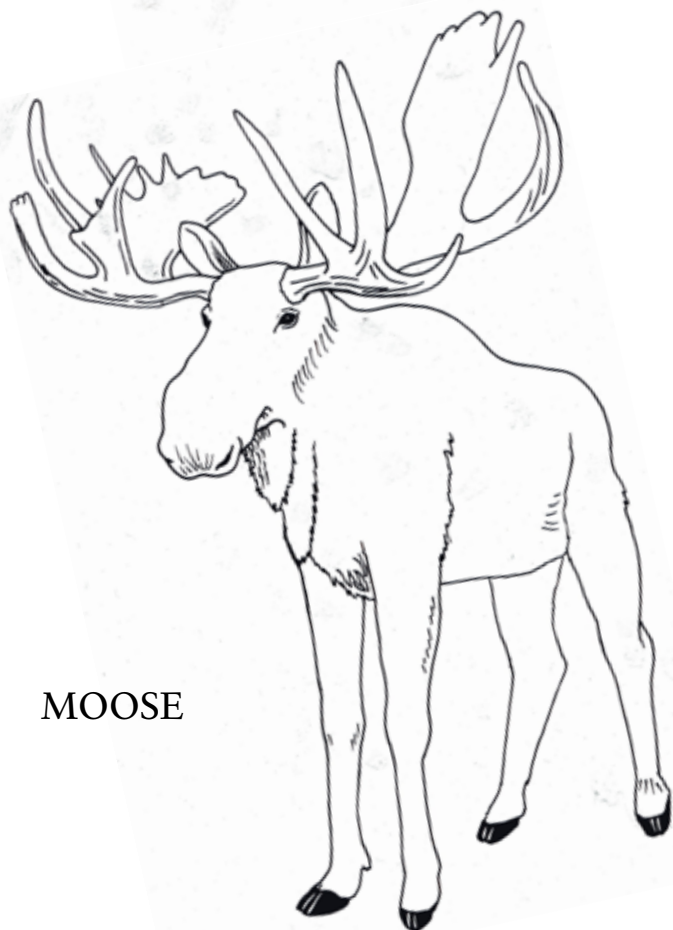
WHITE-TAILED
DEER



BEAVER



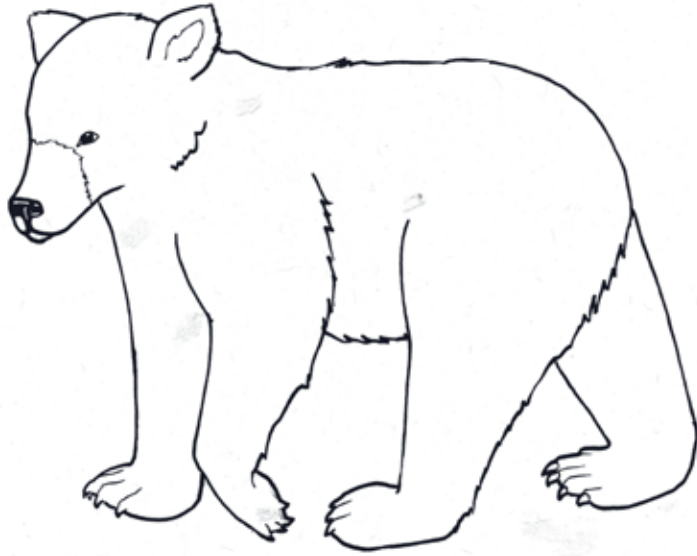
FOX



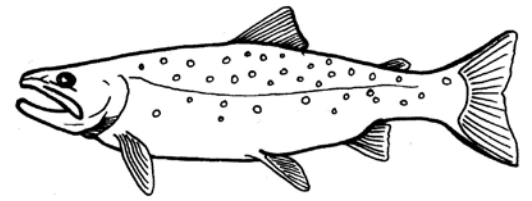
MOOSE



BIGHORN SHEEP



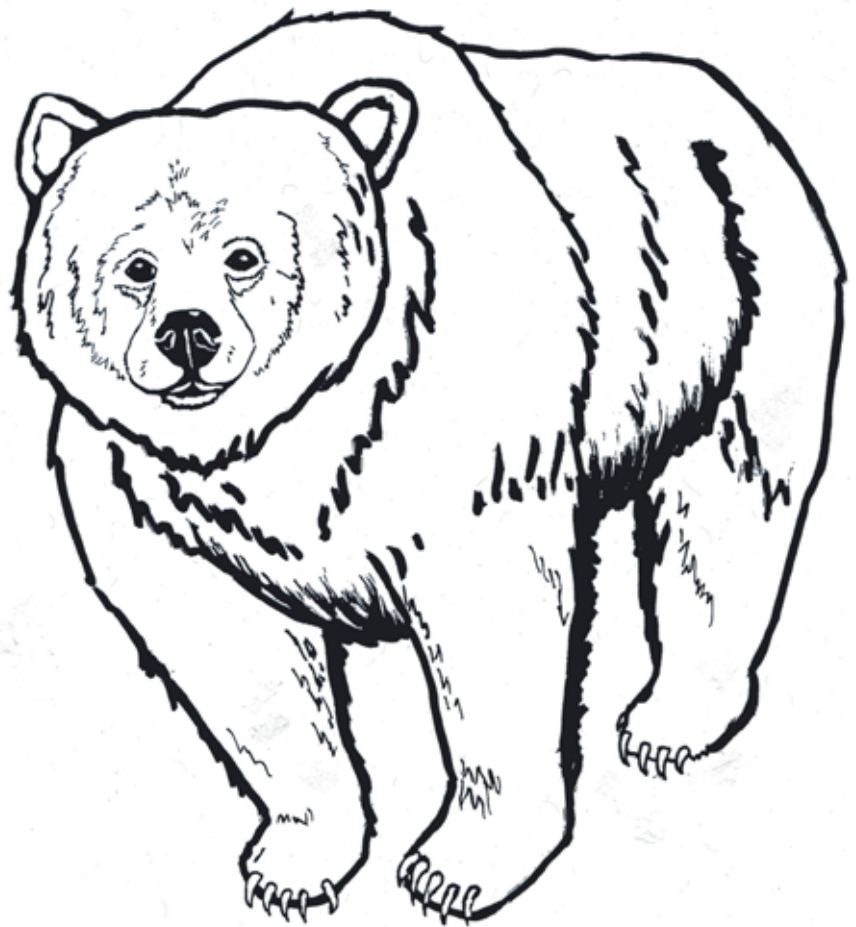
BLACK BEAR



BULL TROUT

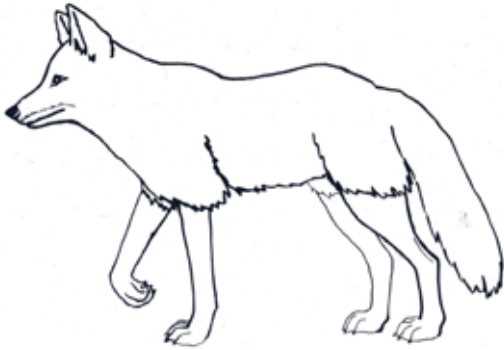


GREAT HORNED OWL

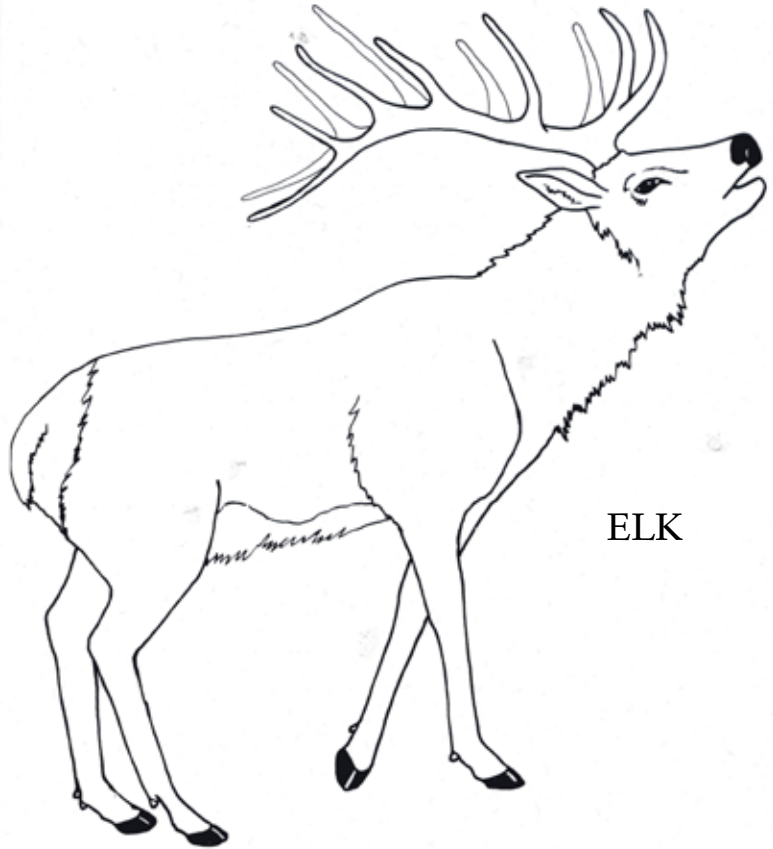


GRIZZLY BEAR

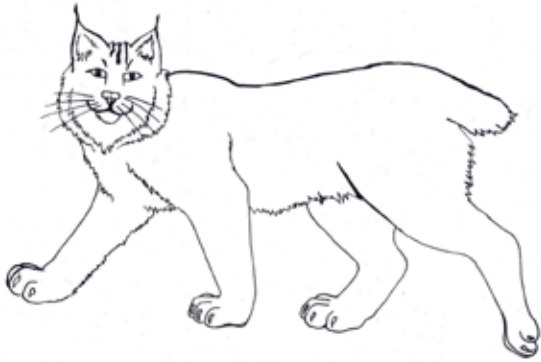
COYOTE



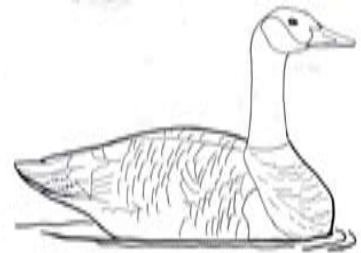
ELK



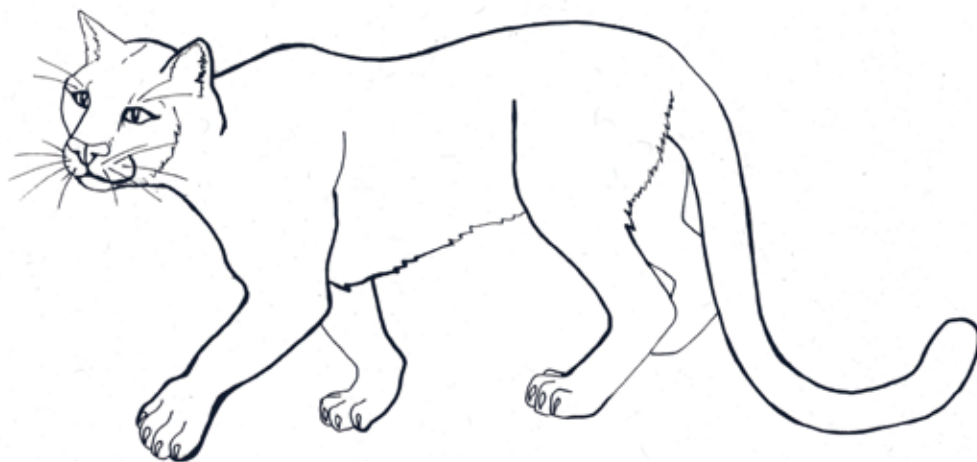
LYNX



CANADA
GOOSE



MOUNTAIN LION





GREAT BLUE HERON



BEETLE



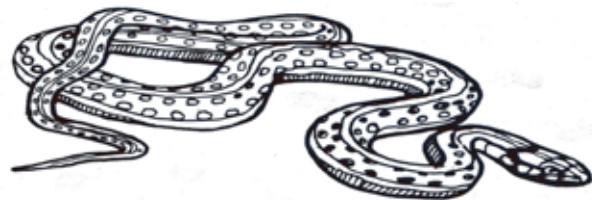
HUMMINGBIRD



PIKA

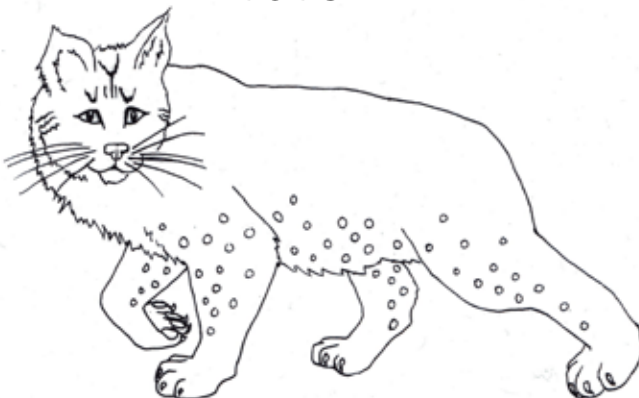


FROG



SNAKE

BOBCAT



DRAGONFLY



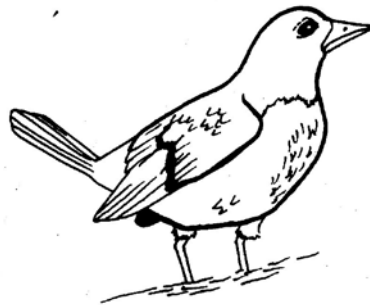
TREE SQUIRREL



HOVER FLY



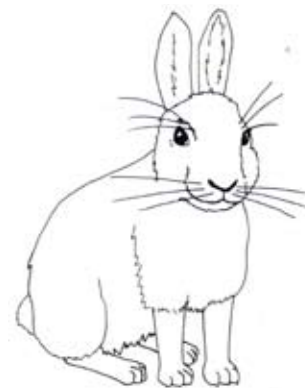
SNOW FLEA



DIPPER



RIVER OTTER



SNOWSHOE HARE



SNOWY OWL



SPIDER



BALD
EAGLE

Birds of Glacier National Park Field Check List

Common names conform with the A.O.U. Check List of North American Birds (6th edition, 1983). List compiled and revised by David S. Shea, November 1971, April 1976, December 1977, February 1983, January 1990, April 1995, and March 2004.

E--occurs on east side of the Park (East of Continental Divide)

W--occurs on west side of the Park (West of Continental Divide)

A--occurs in alpine areas

ab-- abundant c-- common u --uncommon r-- rare a --accidental i -- introduced • -- known to nest in the Park

S -Spring (March-May) S -Summer (June-August) F -Fall (September-November) W -Winter (December-February)

LOONS

Common Loon • E, W

Yellow-billed Loon W

Pacific Loon W

Red-throated Loon W

GREBES

Red-necked Grebe E, W

Horned Grebe E, W

Eared Grebe E, W

Western Grebe E, W

Pied-billed Grebe E, W

PELICANS, CORMORANTS

American White Pelican E, W

Double-crested Cormorant E, W

HERONS, BITTERNs

Great Blue Heron • E, W

Great Egret W

Black-crowned Night Heron W

American Bittern • E, W

SWANS, GEESE, DUCKS

Tundra Swan E, W

Trumpeter Swan E, W

Canada Goose • E, W

White-fronted Goose W

Snow Goose

Ross' Goose E, W

Mallard • E, W

Gadwall E, W

Northern Pintail E, W

Green-winged Teal E, W

Blue-winged Teal E, W

Cinnamon Teal E, W

Eurasian Wigeon W

American Wigeon E, W

Northern Shoveler E, W

S S FW

u u u r

a

r

a

u u u r

c u u u

u u u

u u u r

r r r r

r r

r r

u u u r

r

a

r r

c c

r r r

c c c u

r

u r u

r

c c c c

u u u r

u u u r

u u u

u u u

u u u

a a a

c c c r

u u u r

Wood Duck • E, W

Redhead E, W

Ring-necked Duck • E, W

Canvasback E, W

Greater Scaup W

Lesser Scaup E, W

Common Goldeneye • E, W

Barrow's Goldeneye • E, W

Bufflehead E, W

Long-tailed Duck W

Harlequin Duck • E, W

White-winged Scoter E, W

Surf Scoter W

Ruddy Duck E, W

Hooded Merganser • E, W

Common Merganser • E, W

Red-breasted Merganser • E, W

VULTURES, HAWKS, EAGLES

Turkey Vulture E, W

Northern Goshawk • E, W

Sharp-shinned Hawk • E, W

Cooper's Hawk • E, W

Red-tailed Hawk • E, W

Red-shouldered Hawk W

Broad-winged Hawk E, W

Swainson's Hawk • E, W

Rough-legged Hawk E, W

Ferruginous Hawk E, W

Golden Eagle • E, W, A

Bald Eagle • E, W

Northern Harrier E, W

Osprey • E, W

Prairie Falcon • E, W, A

Peregrine Falcon E, W

Merlin E, W, A

Gyr Falcon A

American Kestrel • E, W

S S FW

u u u r

u u r

c u u

r r

a

u u u r

c c c u

c c c r

c c c u

a

u u r

u u

r

u r u

u u u r

c c c u

r r

u u

u u u u

u u u r

u u u u

c c c

a

a a

r r r

r r r

r

c c c r

u u u u

u u u

u u u

u u u r

r r r

r r r

a a

u u u

	S S FW		S S FW
GROUSE, PTARMIGAN		Caspian Tern E	r r
Blue Grouse • E, W, A	c c c c	Black Tern • E, W	u u
Spruce Grouse • E, W	c c c c		
Ruffed Grouse • E, W	c c c c	PIGEONS, DOVES	
Willow Ptarmigan A	a	Band-tailed Pigeon W	a
White-tailed Ptarmigan • A	u u u u	Rock Dove E, W, i	r r
Sharp-tailed Grouse E	r	Mourning Dove E, W	u u u
Ring-necked Pheasant W, i	r		
Gray Partridge W, i	r	OWLS	
		Western Screech Owl • E, W	r r r r
CRANES		Great Horned Owl • E, W	u u u u
Sandhill Crane • E, W	r r r	Snowy Owl E, W	r r
		Northern Hawk Owl • E, W	r r r
WRAILS, COOTS		Northern Pygmy Owl • E, W	u u u u
Sora • E, W	u u	Burrowing Owl W	r
American Coot E, W	c c c	Barred Owl • E, W	u u u u
		Great Gray Owl • E, W	r r r r
SHOREBIRDS		Long-eared Owl • E, W	r r
Killdeer • E, W	c c c r	Short-eared Owl E, W	r r
Semipalmated Plover E, W	a a	Boreal Owl • E, W	r r r r
Black-bellied Plover E, W	a a	Northern Saw-whet Owl • E, W	r r r r
Black Turnstone E	a		
Common Snipe • E, W	c c u	NIGHTHAWKS, SWIFTS	
Long-billed Curlew E, W	u	Common Nighthawk • E, W	u u
Upland Sandpiper E	r	Black Swift • E, W, A	r r
Spotted Sandpiper • E, W, A	c c c	Vaux's Swift • E, W	u u
Solitary Sandpiper E, W	u u u	White-throated Swift E, W, A	r r
Willet E, W	r r		
Greater Yellowlegs E, W	r	HUMMINGBIRDS	
Lesser Yellowlegs E, W	r r	Black-chinned Hummingbird W	r r
Pectoral Sandpiper E, W	r	Broad-tailed Hummingbird E, W	r r
Baird's Sandpiper E, W	r r r	Rufous Hummingbird • E, W, A	c c
Least Sandpiper W	r	Calliope Hummingbird • E, W, A	c c
Semipalmated Sandpiper W	r r		
Western Sandpiper W	r r	KINGFISHERS	
Sanderling W	r	Belted Kingfisher • E, W	u u u r
Long-billed Dowitcher E, W	r		
Marbled Godwit E, W	r	WOODPECKERS	
American Avocet E, W	u u	Northern Flicker • E, W	c c c r
Wilson's Phalarope E, W	u u	Pileated Woodpecker • E, W	c c c c
Red-necked Phalarope E, W	r r r	Red-headed Woodpecker E	a
		Lewis' Woodpecker E, W	u u
GULLS, TERNS		Red-naped Sapsucker • E, W	c c u
Glaucous Gull W	a	Williamson's Sapsucker • E, W	r r
Glaucous-winged Gull W	a	Hairy Woodpecker • E, W	c c c c
Herring Gull E, W	r	Downy Woodpecker • E, W	c c c c
California Gull E, W	c c c	White-headed Woodpecker W	a
Ring-billed Gull E, W	c c c	Black-backed Woodpecker • E, W	r r r r
Franklin's Gull E, W	u u	Three-toed Woodpecker • E, W	c c c c
Bonaparte's Gull E, W	r u		
Black-legged Kittiwake W	a	FLYCATCHERS	
Forster's Tern E, W	r	Eastern Kingbird • E, W	u u
Common Tern E	r r	Western Kingbird E, W	u u

Scissor-tailed Flycatcher W
 Ash-throated Flycatcher W
 Say's Phoebe E, W
 Willow Flycatcher • E, W
 Least Flycatcher E, W
 Hammond's Flycatcher • E, W
 Dusky Flycatcher • E, W
 Cordilleran Flycatcher E, W
 Western Wood Pewee • E, W
 Olive-sided Flycatcher • E, W

LARKS

Horned Lark • E, W, A

SWALLOWS

Violet-green Swallow • E, W, A
 Tree Swallow • E, W
 Bank Swallow • E, W
 Rough-winged Swallow • E, W
 Barn Swallow • E, W
 Cliff Swallow • E, W, A

JAYS, MAGPIES, CROWS, RAVENS

Gray Jay • E, W
 Blue Jay E, W
 Steller's Jay • E, W
 Black-billed Magpie • E, W
 Common Raven • E, W, A
 American Crow • E, W
 Clark's Nutcracker • E, W, A

CHICKADEES

Black-capped Chickadee • E, W
 Mountain Chickadee • E, W
 Boreal Chickadee • E, W
 Chestnut-backed Chickadee • E, W, A

NUTHATCHES, CREEPERS

White-breasted Nuthatch • E, W
 Red-breasted Nuthatch • E, W
 Brown Creeper • E, W

DIPPERS, WRENS

American Dipper • E, W
 House Wren • E, W
 Winter Wren • E, W
 Marsh Wren W
 Rock Wren • E, W, A

MOCKINGBIRD, CATBIRDS

Northern Mockingbird W
 Gray Catbird • E, W
 Sage Thrasher W

S S FW

a
 a
 r r
 u u
 r r
 c c
 u u
 r r
 u u
 u u

r r r r

c c u
 abab u
 u u u
 u u u
 c c u
 c c u

c c c c
 r r
 c c c c
 u u u u
 c c c c
 u u u r
 u u u u

c c c c
 c c c c
 u u u u
 u u u u

r r r r
 c c c c
 c c c u

c c c u
 u u
 c c u r
 a
 u u u

r
 s s fw
 a

THRUSHES, BLUEBIRDS, SOLITAIRES

American Robin • E, W
 Varied Thrush • E, W
 Hermit Thrush • E, W, A
 Swainson's Thrush • E, W
 Veery • E, W
 Eastern Bluebird E
 Western Bluebird E, W
 Mountain Bluebird • E, W, A
 Townsend's Solitaire • E, W, A

KINGLETS

Golden-crowned Kinglet • E, W
 Ruby-crowned Kinglet • E, W

PIPITS

Water Pipit • E, W, A
 Sprague's Pipit E

WAXWINGS

Bohemian Waxwing E, W
 Cedar Waxwing • E, W

SHRIKES

Northern Shrike E, W
 Loggerhead Shrike E, W

STARLINGS

European Starling • E, W, i

VIREOS

Cassin's Vireo E, W
 Red-eyed Vireo • E, W
 Warbling Vireo • E, W

WARBLERS

Black-and-white Warbler E
 Tennessee Warbler E, W
 Orange-crowned Warbler • E, W
 Nashville Warbler E, W
 Parula Warbler W
 Yellow Warbler • E, W
 Cape May Warbler E, W
 Yellow-rumped Warbler • E, W
 Townsend's Warbler • E, W
 Bay-breasted Warbler W
 Blackpoll Warbler E, W
 Ovenbird E
 Northern Waterthrush • E, W
 MacGillivray's Warbler • E, W
 Common Yellowthroat • E, W
 Wilson's Warbler • E, W
 American Redstart • E, W

S S FW

abab c r
 c c c u
 c c c
 abab c
 u u u
 a
 r
 c c c
 c c c

abab c u
 c c c

u u u
 r

r r r
 c c c

r r r
 r r r

u u u r

c c
 u u
 c c

a
 r r
 u u
 r
 a
 c c u
 a a a
 c c u a

c c
 a
 r
 r
 c c
 c c
 c c
 c c
 u u

BLACKBIRDS, ORIOLES

Bobolink E, W	r
Western Meadowlark • E, W	u u u
Yellow-headed Blackbird E, W	r
Red-winged Blackbird • E, W	c c
Bullock's Oriole • E, W	r r
Rusty Blackbird E, W	r r
Brewer's Blackbird E, W	r u u r
Common Grackle E	r
Brown-headed Cowbird • E, W	u u u

TANAGERS, GROSBEAKS

Western Tanager • E, W	c c r
Rose-breasted Grosbeak E, W	a
Black-headed Grosbeak • E, W	r r r
Evening Grosbeak • E, W	c c c c
Pine Grosbeak • E, W	u u u u

BUNTINGS, FINCHES, SPARROWS

Indigo Bunting W	r
Lazuli Bunting • E, W	u u
Lark Bunting E, W	r
Snow Bunting E, W	u u u
Cassin's Finch E, W	u u u
House Finch W	r r
Gray-crowned Rosy Finch • E, W, A	u u u u
Common Redpoll E, W	u u u
Hoary Redpoll W	r
Pine Siskin • E, W, A	c c c u
American Goldfinch E, W	r r r
Red Crossbill • E, W	c c c c
White-winged Crossbill E, W	u u u u
Green-tailed Towhee E	a
Spotted Towhee E, W	u u
Savannah Sparrow • E, W	c c
LeConte's Sparrow • E, W	r r
Vesper Sparrow • E, W	u u u
Lark Sparrow W	r
American Tree Sparrow E, W	r r r
Chipping Sparrow • E, W	c c u
Clay-colored Sparrow • E, W	u u
Brewer's Sparrow • E, W	u u
Field Sparrow W	a
Harris' Sparrow E, W	r r
White-crowned Sparrow • E, W, A	c c c
Golden-crowned Sparrow E, W	c c c
White-throated Sparrow E, W	r r
Fox Sparrow • E, W	c c u
Lincoln's Sparrow • E, W	u u u
Song Sparrow • E, W	u u u r
Dark-eyed Junco • E, W	abababu
McCown's Longspur E, W	r r
Lapland Longspur E, W	u u u
Chestnut-collared Longspur E, W	u

Mammals of Glacier National Park*

*Common and scientific names from R. S. Hoffman and D. L. Pattie, A Guide to Montana Mammals, 1968. Compiled by David S. Shea, November, 1971 and revised August, 1986, and April, 1995.

E Occurs east of the Continental Divide, Spruce-fir forest, aspen, bunchgrass meadows

W Occurs west of the Continental Divide, Cedar - hemlock - yew - lodgepole - fir - western larch forest, some meadows

A Occurs in alpine areas, Above upper edge of continuous forest, open areas, makes up about 1/3 of park along Continental Divide.

I Occurs only rarely in the park.

ORDER INSECTIVORA - SHREWS

Pygmy shrew (*Sorex hoyi*) W

Dry, open coniferous forests

Masked shrew (*Sorex cinereus*) E W

Coniferous forests, meadows, ponds and stream edges

Vagrant shrew (*Sorex vagrans*) E W A

Moist forests and grasslands, marsh and stream edges

Montane shrew (*Sorex monticolus*) E W

Higher elevation coniferous forests

Northern water shrew (*Sorex palustris*) E W

Stream edges

ORDER CHIROPTERA - BATS

Little brown bat (*Myotis lucifugus*) E W

Coniferous forests, often around buildings, caves, nocturnal

Long-eared bat (*Myotis evotis*) E W A I

Coniferous forests, meadows, nocturnal

Long-legged bat (*Myotis volans*) E W A

Coniferous forests, meadows, nocturnal

Big brown bat (*Eptesicus fuscus*) E W

Coniferous forests, often around buildings, caves, nocturnal

Silver-haired bat (*Lasionycteris noctivagans*) E W

Coniferous forests, meadows, nocturnal

Hoary bat (*Lasiurus cinereus*) E W I

Coniferous forests, mostly nocturnal

ORDER CARNIVORA - CARNIVORES

Bobcat (*Lynx rufus*) E W I

Open forests, brushy areas

Lynx (*Lynx lynx*) E W

Coniferous forests

Mountain lion (*Felis concolor*) E W

Coniferous forests

Raccoon (*Procyon lotor*) E W I

Open forests, stream bottoms

Black bear (*Ursus americanus*) E W A

Forests, slide areas, alpine meadows

Grizzly bear (*Ursus arctos*) E W A

Forests, slide areas, alpine meadows

Red fox (*Vulpes vulpes*) E

Grasslands, open forest

Coyote (*Canis latrans*) E W A

Forests, grasslands

Wolf (*Canis lupus*) E W

Coniferous forests

Striped skunk (*Mephitis mephitis*) E W

Open forests, grasslands

Badger (*Taxidea taxus*) E W

Grasslands

River otter (*Lontra canadensis*) E W I

Rivers, lakes

Wolverine (*Gulo gulo*) E W A

Coniferous forests, alpine meadows

Least weasel (*Mustela nivalis*) E W I

Open forests, grasslands

Short-tailed weasel (*Mustela erminea*) E W A

Coniferous forests, meadows

Long-tailed weasel (*Mustela frenata*) E W A

Open forests, meadows

Mink (*Mustela vison*) E W

Creek and lake edges

Marten (*Martes americana*) E W A

Coniferous forests

Fisher (*Martes pennanti*) E W I

Coniferous forests

ORDER LAGOMORPHA - PIKAS, RABBITS, HARES

Pika (*Ochotona princeps*) E W A

Rockslides

Snowshoe hare (*Lepus americanus*) E W

Coniferous forests

White-tailed jackrabbit (*Lepus townsendii*) E I

Grasslands

ORDER RODENTIA - RODENTS

Porcupine (*Erethizon dorsatum*) E W A

Coniferous forests

Beaver (*Castor canadensis*) E W

Streams, lakes

Northern pocket gopher (*Thomomys talpoides*) E W A

Meadows

Yellow-bellied marmot (*Marmota flaviventris*) E I

Open rocky foothills, talus slopes

Hoary marmot (*Marmota caligata*) E W A

Rocky areas, alpine meadows

Least chipmunk (*Eutamias minimus*) E W A

High open forests, brushy, rocky areas, alpine meadows

Yellow pine chipmunk (*Eutamias amoenus*) E W

Open forests, brushy, rocky areas

Red-tailed chipmunk (*Eutamias ruficaudus*) E W

Open forest, brushy, rocky areas

Golden-mantled ground squirrel (*Spermophilus lateralis*) E W A

High open forests, rocky areas

Columbian ground squirrel (*Spermophilus columbianus*) E W A

Open woodlands, grasslands, alpine meadows

Thirteen-lined ground squirrel E I

(*Spermophilus tridecemlineatus*)

Grasslands

Richardson ground squirrel (*Spermophilus richardsoni*) E I

Grasslands

Northern flying squirrel (*Glaucomys sabrinus*) E W

Coniferous forests, nocturnal

Red squirrel (*Tamiasciurus hudsonicus*) E W

Coniferous forests

Western jumping mouse (*Zapus princeps*) E W A

Grasslands, alpine meadows

Bushy-tailed wood rat (*Neotoma cinerea*) E W A

Rocky areas, old buildings

Deer mouse (*Peromyscus maniculatus*) E W A

Forests, grasslands, alpine meadows

Muskrat (*Ondatra zibethicus*) W

Streams, lakes, marshy areas

Northern bog lemming (*Synaptomys borealis*) W I

Coniferous forests

Red-backed vole (*Clethrionomys gapperi*) E W

Coniferous forests

Montane heather vole (*Phenacomys intermedius*) E W A

Coniferous forests, alpine meadows

Water vole (*Arvicola richardsoni*) E W A

High elevation stream and lake edges

Long-tailed vole (*Microtus longicaudus*) E W

Coniferous forests, grasslands

Meadow vole (*Microtus pennsylvanicus*) E W

Open forests, meadows, along streams, marshy areas.

American elk (*Cervus elaphus*) E W A

Open forests, meadows

Moose (*Alces alces*) E W

Coniferous forests, lakes, slow streams, marshy areas

Bighorn sheep (*Ovis canadensis*) E W

Open mountainous areas

Mountain goat (*Oreamnos americanus*) E W A

High peaks and meadows

ORDER ARTIODACTYLA - EVEN-TOED UNGULATES

White-tailed deer (*Odocoileus virginianus*) E W

Coniferous forests, meadows, creek and river bottoms

Mule deer (*Odocoileus hemionus*) E W A

Open forests, meadows, often at high elevations

Vocabulary

The following key will help you to pick out words that are appropriate for the program or topic you are studying:

Senses/Wildlife/Habitat (H)

Forest Processes (F)

Earth Science (E)

Scientific Words (S)

Fire Ecology (FE)

Winter (W)

People, Culture, and Protected Places (P)

- W ACCLIMATIZATION: Seasonal or long-term physiological adjustment, usually in response to temperature changes.
- H, F, W ADAPTATION: A structure or behavior that helps a living thing meet its basic needs & survive in its environment.
- W AGE HARDENING: Process of snow crystals changing within the snow pack over time.
- H, F ALPINE: Type of habitat above tree line with short summers and long winter. Conditions tend to be more severe.
- E ALTITUDE: Height above sea level on Earth.
- W ALTITUDINAL MIGRATORS: Animals that move seasonally from higher or lower elevations to the opposite.
- E ALTYN FORMATION: Oldest Precambrian Belt formation; tan, white, and full of sand grains.
- H ANIMAL: Living thing that gets energy from eating other living things.
- W ANTI-FREEZE: Substance that lowers the temperature at which something normally freezes or retards or prevents freezing.
- E APPEKUNY: Rock formation that is 3500 ft thick green mudstone. Next above the Altyn formation.
- H AQUATIC: Growing, living in, or frequenting the water.
- W ATMOSPHERE: The layer of gases that surround the earth.
- E AVALANCHE: A large mass of snow or ice that suddenly falls from a mountain slope.
- W AXIS: A line about which a rotating body turns.
- F BARK: Tissue covering stems, branches, and roots of a tree or shrub.
- E BEDROCK: Continuous solid rock that forms the Earth's surface.
- H, F BIODIVERSITY: The variety of different species in an area.
- H BIOME: A large geographic area with somewhat uniform climatic conditions.
- W BIRD CROP: A pouch in bird's throat: a pouch in the throat of many birds in which they store food before regurgitating it to feed their young.
- P BLACKFEET: Native American tribe whose traditional life was based on nomadic buffalo hunting.
- P BLACKFOOT CONFEDERACY: A Native American confederacy located on the northern Great Plains, composed of the Blackfeet, Blood, and Pikuni tribes.
- W BLIZZARD: A violent snowstorm with winds blowing at a minimum speed of 35 miles (56 kilometers) per hour and visibility of less than one-quarter mile (400 meters) for three hours.
- F BROAD-LEAVED TREE: Tree with wide-bladed leaves. A flowering tree.
- W BUD: A small protuberance on the stem or branches of a plant, containing the rudiments of future leaves, flowers, or stems; an undeveloped branch or flower.

- W CACHE: A hiding place used especially for storing provisions (food).
- F CAMBIUM: Thin, nutrient rich, layer of living cells beneath a tree or shrub's bark.
- W CAMOUFLAGE: To conceal by the use of disguise or by protective coloring or garments that blend in with the surrounding environment.
- F CANOPY: Layer formed by the leaves and branches of the forest's tallest trees.
- F CARBON DIOXIDE: One of many gases in Earth's atmosphere. Carbon dioxide is produced by combustion and respiration.
- H CARNIVORE: An organism that eats other animals. A meat-eater.
- E CENOZOIC: Present era, beginning 65 million years ago, the ascent of mammals.
- H CHANGE: To make different.
- FE CHARRED FUEL: Fuel that is partly burned, with its outside surface blackened.
- S CHEMIST: A person who studies the structure and composition of substances and how they interact(chemistry) or uses chemistry in his or her work.
- W CHINOOK: Indian word for "snow eater" that refers to a warm dry wind that descends from the eastern slopes of the Rocky Mountains, causing a rapid rise in temperature.
- W CHIONEUPHORE: Organisms that have adjusted their life to winter and can survive although they have not developed any special adaptations for survival.
- W CHIONOPHILE: Organisms that possess definite adaptations for life in a winter environment.
- W CHIONOPHOBE: Organisms unable to adjust to live in the nival environment.
- E CHLORITE: Generally green or black secondary mineral caused by metamorphic alteration.
- E CIRQUE: Bowl-shape carved from a mountain mainly by ice plucking and frost action.
- H CLASSIFICATION: A system that groups organisms based on similarities and differences of their traits.
- E CLIMATE CHANGE: Change in the world's climate, naturally or unnaturally caused.
- E, W CLIMATE: The meteorological conditions, including temperature, precipitation, and wind, which characteristically prevail in a particular region.
- W COCOON: A protective case of silk or similar fibrous material spun by the larvae of moths and other insects that serves as a covering for their pupal stage.
- H COLD BLOODED: Blood temperature is directly influenced by surrounding temps (fishes, reptiles...); poikilotherm.
- FE COMBUSTION: The process of burning; the process of combining a substance with oxygen and a heat source, which produces heat and light.
- H, F COMMUNITY: All of the living things that occupy a habitat.
- W CONDENSATION: Change of a substance from the gaseous (vapor) to the liquid state.
- W CONDUCTION: Transfer of heat from one substance to another by molecular collisions, in other words by direct contact (such as heat lost by touching cold solids and liquids).
- P CONFEDERATED SALISH & KOOTENAI TRIBES: Comprised of the Bitterroot Salish, the Pend d'Oreille and the Kootenai tribes. The Flathead Reservation of 1.317 million acres in northwest Montana is their home now but their ancestors lived in the territory now known as western Montana, parts of Idaho, British Columbia and Wyoming.
- F CONIFER: A cone-bearing tree.
- H CONSUMER: Uses the producers for its food source.
-

-
- W CONSTRUCTIVE METAMORPHISM: The process in which ice crystals favorably situated in the snowpack grow by accretion of water onto their surfaces.
- E, W CONTINENTAL DIVIDE: The line of summits or passes of the Rocky Mountains, separating streams flowing west toward the Pacific Ocean from those flowing toward south toward the Gulf of Mexico and north toward the Hudson Bay.
- S CONTROL: The aspects of an experiment that are held constant so they will not affect the experiment's outcome; a standard of comparison against which scientists check the outcome of experimental treatments.
- FE, W CONVECTION: 1) Transfer of heat by a moving fluid (such as wind or water passing over object). 2) The diffusion of heat through a liquid or gas by means of molecular motion. Because gases expand when heated, much of the heat from a fire diffuses upward from a burning surface through the process of convection.
- FE CROWN FIRE: Fire that spreads in the crowns of trees and shrubs. Crown fires are usually ignited by surface fire. They are common in coniferous forests and chaparral-type shrublands.
- P CROWN OF THE CONTINENT ECOSYSTEM: The ecosystem that is centered around Waterton-Glacier International Peace Park and stretches along the axis of the Rocky Mountains between the Canadian Central Rockies (Banff-Yoko-Kootenay Complex) and the Greater Yellowstone Ecosystem. It includes all the living and non-living components and is known for its tremendous biodiversity.
- P CULTURE: Patterns, traits, and products of a particular period, class, community, or population.
- W DAY LENGTH: Duration of the period from sunrise to sunset.
- H, F DECAY: Decomposition, rot.
- F, W DECIDUOUS: Shedding or losing foliage at the end of the growing season; A tree that loses its leaves in the fall (examples are aspen, larch, birch, cottonwood).
- H, F DECOMPOSE: The mechanical or chemical breakdown of dead organic material into inorganic materials.
- H, F DECOMPOSER: When dead things get eaten by bacteria, fungus, insects, and other organisms and get broken down into smaller pieces.
- E DEPOSITION: The process in which rock moved by water, wind, or ice is dropped in a new place.
- W DEPTH HOAR: Brittle ice crystals, often hollow and cuplike, formed in warmer layers of the snow pack as a result of continuous vapor loss from their surfaces.
- W DESTRUCTIVE METAMORPHISM: The process in which new-fallen snow crystals lose their delicate structure by a redistribution of internal energy, and coalesce into rounded ice grains.
- F DICHOTOMOUS: Divide into two parts (deciduous vs. evergreen).
- FE DISPERSION: The process of scattering or spreading, often used to refer to the way in which smoke disperses through the atmosphere.
- H, F DIVERSITY: Variety.
- F, W DORMANT: Not actively growing; in an inactive state, when growth and development slow or cease, in order to survive adverse environmental conditions. Example, trees are dormant in the winter.
-

- F DUFF: Partially decomposed organic matter (recently living organisms) lying beneath the litter (dead plant material) layer and above the mineral soil.
- E EARTH SCIENCE: Any of various sciences, as geography, geology, or meteorology, that deal with the earth, its composition, or any of its changing aspects.
- W EARTH'S AXIS: The Earth's axis is an imaginary line drawn through its center from its North Pole to its South Pole.
- E EARTH'S CRUST: The outer part of the Earth. The visible surface.
- W ECOLOGY: Study of the interrelationships between living things and their environment.
- H ECOSYSTEM: All the living and nonliving things that are found in an area.
- E, W ELEVATION: The height to which something is elevated above a point of reference such as the ground or sea level; Height above sea level, expressed in meters or feet.
- E EMPIRE FORMATION: A thin, gray to green, 500 ft. thick formation that rests on top of the Grinnell Formation.
- H ENDANGERED: Plant or animal in danger of extinction throughout all or a significant portion of its range.
- H, F ENERGY: The ability to cause motion or change.
- H, F ENVIRONMENT: The surroundings that an organism lives in.
- F EPIPHYTE: Plant that derives moisture and nutrients from the air and rain; usually grows on another plant but not parasitic on it.
- E EROSION: The movement of weathered rock by water, wind, or ice.
- E ERRATIC: A glacially transported rock fragment.
- F, W EVERGREEN: A tree, shrub, or plant having foliage that persists and remains green throughout the year; most coniferous trees are evergreen.
- S EVIDENCE: Proof; facts that support an idea.
- S EXPERIMENT: A scientific investigation that tests a hypothesis.
- H EXTINCT: Removed from existence. Gone from the planet forever.
- E FAULT: A break in rock which the opposite sides have been relatively displaced.
- F FERN: Flowerless, seedless vascular plants having roots, stems, and fronds and reproducing by spores.
- FE FIRE MANAGEMENT: Actions to prevent wildland fires, suppress them, or manage them for particular purposes, like improvement of wildlife habitat.
- FE FIRE REGIME: The pattern of fire occurrence, size, and severity in an area or ecosystem. An ecosystem's fire regime is like a story about the forces of fire, climate, human use, and species adaptations—all interacting to affect the ecosystem over thousands of years.
- FE FIRE SCAR: A wound at the base of a tree caused by heat damage to the cambium. Fire scars are usually shaped a little bit like triangles. They are often blackened in the center and pitchy around the edges. The tree continues to grow, so its bark gradually curls over the edges of the scar and sometimes buries the scar completely.
- FE FIRE TRIANGLE: The three things necessary for fire: fuel, oxygen, and a source of heat.
- FE FIRESTORM: A wildland fire that results from violent convection. This is caused by a very large, intense fire or many fires that burn together. A firestorm usually produces a towering smoke column, spot fires, and spinning, tornado-like winds.
- FE FLAMMABILITY: The ease with which something will start on fire.
- P FLATHEAD INDIAN RESERVATION: This reservation is home to the Confederated Salish and Kootenai Tribes.
- E FOLDING: Bending in layers of rock.
-

-
-
- H, F FOOD CHAIN: Transfer of food energy from the sun to plants and then through a series of animals, with repeated eating and being eaten.
- H, F FOOD WEB: An interlocking pattern of food chains.
- F FORBS: Low-growing, herbaceous plants (have leaves and stems that die at the end of the growing season). Important part of wildlife habitats.
- F FOREST FLOOR: Layer of decomposing material that covers the soil in a forest.
- H, F FOREST: Habitat type in which trees are the most common member.
- FE FORESTER: A person who studies forests and is concerned with their management, use, and enjoyment.
- E FOSSIL: The remains or traces of an organism that lived long ago.
- W FRONT RANGE: The Front Range is on the eastern edge of the Rocky Mountains and on the western edge of the Great Plains.
- FE FUEL MOISTURE: The amount of moisture in fuels, expressed as a percent or fraction of oven dry weight. Fuel moisture is the most important fuel property controlling flammability.
- FE FUEL: The living and dead vegetation that can be burned in a wildland fire. Fuel includes dead woody material, leaves of trees and shrubs, litter, duff, grasses, and other plants.
- F FUNGI: Consumer organism that decomposes living and dead organisms by digesting their tissues and absorbing the nutrients they contain; Mushrooms and mold are examples.
- F GALL: Abnormal growth on plants cause by many things (insects, chemicals, bacteria).
- E GEOLOGY: Science of the Earth.
- F, W GERMINATE: To begin to sprout or grow; To grow into a plant or individual, as a seed, spore, or bulb.
- E GLACIAL FLOUR: Tiny particles weathered from mountains by glacial forces.
- E, W GLACIER: A body of ice (created when snow crystals change under pressure) flowing on a land surface; A body of ice that flows under its own mass due to gravity.
- E GLOBAL WARMING: An increase in the earth's average atmospheric temperature that causes corresponding changes in climate.
- H, GRASSLAND: Habitat type where grasses are the most common member.
- E GREENHOUSE GAS: Any of the atmospheric gases that contribute to the Greenhouse Effect (CO₂, methane, ozone, fluorocarbons).
- E GRINNELL FORMATION: 2500 ft deep of red mudstone. Lies above the Appekunny mudstone.
- F GROUND COVER: Plants and shrubs in a forest, as a whole.
- FE GROUND FIRE: Fire that burns in dead, decomposing fuels on the forest floor, mostly by smoldering combustion. Fires in duff, peat, dead moss and lichens, and punky wood are typically ground fires.
- W GUARD HAIRS: Coarse hairs that form the outer fur and protect the underfur of certain mammals.
- H HABITAT: A plant or animal's home.
- E HANGING VALLEY: A tributary stream, made by glaciers, whose valley floor lies above that of the valley of a main stream.
- F HEARTWOOD: Dead central woody core of a tree trunk. Provides structure to tree.
-
-

- FE HEAT: A form of energy that raises the temperature of matter.
- W HUDDLE: To crowd together, as from cold or fear.
- E HELENA FORMATION: 3,300 ft thick at its thickest part, this formation makes up many of the noticeable peaks in the park. Dark gray to tan, and heavily jointed. Rests on top of the Empire Formation.
- E HEMATITE: Black to brick-red mineral, chief ore of iron. Found in red Grinnell formation.
- W HEMISPHERE: Either the northern or southern half of the earth as divided by the equator or the eastern or western half as divided by a meridian.
- H, F HERBIVORES: Animals that eat only plants.
- H HIBERNATE: Sleeping through the winter. An adaptation to survive winter.
- W HIBERNATION: A physical state where an animal's body functions slow down in order to conserve energy through a season of no food, water, and cold temperatures.
- S HISTOGRAM: A graph of the frequency distribution of observations.
- W HORMONES: Chemical messengers sent throughout the body.
- W HYPOTHALMUS: That region of the brain which regulates temperature-control mechanisms in the body.
- W HYPOTHERMIA: A condition in which the body core temperature falls below that considered normal for a warm blooded animal.
- E HORN: A bare, pyramid-shaped peak left standing where glacial action in cirques has eaten into it from three or more sides.
- F HUMUS: The decomposed residue of plant and animal tissues.
- E ICE AGE: A cold period marked by episodes of extensive glaciation alternating with episodes of relative warmth.
- E ICE SHEET: A broad glacier of irregular shape, generally blanketing a large land surface.
- E IGNEOUS ROCK: Rock formed by solidification of molten magma materials.
- W INSOLATION: Incoming solar radiation.
- FE INSULATION: 1) Materials which retard the flow of heat (fat, fur, feathers, etc.). 2) Material that absorbs heat slowly and releases it slowly, so it can be used to protect an object from rapid heating or cooling
- E INTERDEPENDENCE: when 2 or more living things in nature need one another to survive.
- E INTERGLACIAL PERIOD: Time between ice ages. Current era started 11,400 years ago.
- P INTERNATIONAL BIOSPHERE RESERVE: One location in a network of protected samples of the world's major ecosystem types devoted to conservation of nature and scientific research in the service of man. It provides a standard against which the effect of man's impact on his environment can be measured.
- P INTERNATIONAL PEACE PARK: A protected area that celebrates neighborly relations between two or more nations and recognizes that political boundaries are only recognized by humans and ecosystems are continuous across boundaries. Also called trans-boundary protected areas in many parts of the world. Waterton-Glacier International Peace Park was the world's first international peace park and has inspired many other countries to create shared protected areas.
- E INTERRELATIONSHIP: the relationships between plants and plants, plants and animals, and animals and animals.
-

-
- W INTRANIVEAN: Within the snow.
- E ISOTOPE: One of two or more atoms having the same atomic number but different mass numbers.
- P KOOTENAI: There are six bands of the Kootenai Nation, an area that later was drawn as North Idaho, northwest Montana and southeastern British Columbia. Their lifestyle was semi-nomadic, sustained through hunting, fishing and gathering. Anthropologists classify the Kootenai Tribe as belonging to the “basin culture.” In the 1855 Hellgate Treaty, these Tribes ceded to the United States all the land they occupied or claimed in exchange for reservations.
- FE LADDER FUELS: Shrubs and small trees that fill the space between the forest floor and tree crowns with flammable material, so a fire might be able to “climb the ladder” from surface fuels into the treetops.
- W METABOLIC RATE: The amount of energy expended in a give period.
- E LANDFORM: A natural structure or feature on Earth’s surface.
- W LATITUDE: 1) Distance north or south of the Equator on Earth’s surface. 2) The angular distance north or south of the earth’s equator, measured in degrees along a meridian, as on a map or globe.
- F LEAF: Main location of photosynthesis in plants.
- F LEAF LITTER: Top layer of the forest floor, not yet rotten.
- W LEAF SCARS: Where leaves were attached, can be found on older stems transformed to appear superficially like lenticels.
- P LEAVE NO TRACE: Set rules of how to use the outdoors in order to protect it for future generations.
- E LEWIS OVERTHRUST FAULT: Action that folded older rock above younger rock in the northwest United States.
- F LICHEN: 1) Alga and fungus growing together in a symbiotic relationship. 2) A lichen is a symbiotic relationship between a fungus and an alga. The composite organism behaves as a single independent organism.
- H, F LIFE CYCLE: Continuous sequence of changes undergone by an organism.
- E LITHIFICATION: Rock making. Conversion of sediments into sedimentary rocks.
- E LITHOSPHERE: The outer zone of the solid Earth.
- E LITTLE ICE AGE: The period from 1400 to 1800, characterized by expansion of mountain glaciers and cooling of global temperatures, especially in the Alps, Scandinavia, Iceland, and Alaska.
- H, F LIVING: Not dead. Alive (growing, eating, reproducing. . .)
- E MAGMA: Molten lava beneath the Earth’s surface.
- S MAGNIFYING GLASS: Tool used to see things closer up.
- FE MANAGEMENT GOALS: The conditions desired for a wildland area in the future.
- FE MANAGEMENT PLAN: The methods to be used for meeting management goals.
- E MESOZOIC: 230-65 million years ago. Appearance of flowering plants and appearance and disappearance of dinosaurs.
- E METAMORPHIC ROCK: Formed within the Earth’s crust by transforming the rock by heat and pressure.
- S METEOROLOGIST: A person who studies weather and changes in the atmosphere. Meteorologists sometimes use their skills to forecast weather and fuel conditions that affect wildland fire behavior.
-

- H MIGRATE: To change location periodically, especially by moving seasonally from one region to another. Traveling distances to find better food sources. An adaptation to survive winter.
- E MINERAL: A natural compound that is formed through geologic processes.
- FE MOISTURE REQUIREMENT: The amount of moisture needed for an organism to survive.
- E MORaine: A ridgelike accumulation of debris deposited by glaciers.
- H MOSAIC: Differences in land cover appearances (burned vs. unburned areas).
- F MOSS: 1) Any tiny, leafy-stemmed, flowerless plant, reproducing by spores and growing in tufts, sods, or mats on moist ground, tree trunks, rocks, etc. 2) Any of various green, usually small, nonvascular plants of the class Musci of the division Bryophyta.
- E MOUNTAIN BUILDING: The creation of highlands by large-scale changing of rocks in the Earth's crust.
- H, E MOUNTAIN: Any land mass that stands much higher than its surroundings.
- P NAPI: Blackfoot word, "Old Man" The arranger and trickster.
- P NATIONAL FOREST: Forested land owned, maintained, and preserved by the U.S. government.
- P NATIONAL PARK: An area of scenic beauty, historical importance, or the like, owned and maintained by a national government for the use of the people.
- P NATIVE AMERICAN: The first people to inhabit the Americas. Often called "Indians." Locally, the Salish, Kootenai, and Blackfeet tribes have lived in and around Glacier National Park for many generations and regard many sites in Glacier as sacred.
- F NATIVE PLANT: Species of plants and animals that have lived in an area for a very long time.
- S NATURAL RESOURCE: Materials in the environment that are useful to people.
- W NIVEAN: Area above the snow.
- H, F NON-LIVING: Not alive and never was alive.
- F NON-NATIVE PLANT: Not originally found in this area.
- F NURSE LOG: Dead and downed log providing suitable growing conditions for new plant life.
- H, F NUTRIENT: Substances that an organism needs in order to survive and grow.
- S OBSERVATION: Something that you note using your senses.
- F OLD-GROWTH FOREST: Very old forest; OWLS (Old trees, Woody debris, Layers of vegetation, Snags)
- H OMNIVORE: Animal that eats both plant and animal material.
- H, F, W ORGANISM: Any living thing.
- W OVER BROWSING: To feed on leaves, young shoots, and other vegetation; graze to an extent that removes all the vegetation.
- W OVER WINTER: To pass or spend the winter in an area. To remain alive through the winter
- H, W OX-BOW LAKE: A curved lake occupying a cutoff meander loop.
- FE OXYGEN: One of many gases in Earth's atmosphere. Oxygen is produced by photosynthesis and is used in both combustion and respiration.
- E PALEOZOIC: 570-230 million years ago. Appearance of fish, insects and reptiles.
- P PEND d'OREILLES: Also known as the Kalispel, are a tribe of Native Americans who
-

-
- lived centered around Lake Pend Oreille, as well as the Pend Oreille River, although some of them live spread through Montana and eastern Washington. It is one of the three tribes of the Confederated Salish and Kootenai Tribes of the Flathead Nation.
- W PERENNIALS: A plant that lives more than one growing season.
- F PHLOEM: Outer layer of cells produced by a woody plant's cambium. Carry nutrients from leaves to other parts of the plant.
- W PHOTOPERIOD: The amount of light received daily. Total length of time between sunrise and sunset.
- F PHOTOSYNTHESIS: The process of using the energy in sunlight to make food from water and carbon dioxide.
- F PIONEER SPECIES: Earliest plant species to show up in forest succession, usually grasses.
- E PLASTIC FLOW: A continuous and permanent change of shape in any direction with out breakage.
- FE PM-2.5, PM-10: The weight (in micrograms) of smoke particles less than 2.5 (or 10) microns in diameter per cubic meter of air.
- F POLLINATE: Type of plant reproduction involving the transfer of pollen.
- H, F POPULATION: The number of individuals of a particular species living together in a certain location.
- E PRECAMBRIAN: Beginning of Earth's history.
- W PRECIPITATION: Falling moisture: snow, rain, hail, sleet. . . Precipitation is the result of water vapor that has condensed and formed clouds.
- H, W PREDATOR: An animal or other organism (such as a carnivorous plant) that hunts and kills other organisms for food in an act called predation.
- FE PRESCRIBED FIRE: A wildland fire ignited by managers to meet particular goals. A lot of planning is needed to get ready for a prescribed fire. The people who use prescribed fire usually work closely with neighbors and safety experts to make sure the fire will meet their goals safely.
- H, W PREY: An animal that is hunted, caught, and eaten by another animal for food.
- H, F PRODUCER: Green plants which are able to make food from sunlight.
- W PTARMIGAN: Bird that turns white and remains above treeline throughout winter.
- W RADIATION: The propagation of energy through space. The energy received by or emitted from a radiating object. The leading cause of heat loss - occurs when heat is released directly from the body's surface - can be prevented by adequately covering the body.
- E RADIOMETRIC DATING: Determining the age of Earth's materials by using radioactive elements.
- E RAIN SHADOW: An area on the leeward side of a mountain barrier that receives little rainfall.
- FE RANGE MANAGER: A person who manages grasslands or areas containing a lot of grass. Range managers often plan and control grazing of grasslands.
- S RENEWABLE RESOURCE: Living resources, such as plants and animals, which have the capacity to renew themselves.
- H, F REPRODUCE: To make more organisms of the same kind.
-

- H, W RESIST: Staying in an area and coping with conditions. An adaptation to survive winter.
- W RESISTANCE: Staying and enduring challenges of winter and resisting its stresses.
- S RESOURCE: Something that is used with in an environment and upon which people have therefore placed or assigned value. An example would be water.
- H, F RESPIRATION: 1) Breathing. 2) The process in which living cells obtain energy by breaking down carbon compounds and combining them with oxygen, releasing carbon dioxide and water.
- E ROCK CYCLE: The creation, destruction, and alteration of rocks that occurs over and over again.
- E ROCK FLOUR (SEE GLACIAL FLOUR): Fine sand and silt produced by crushing and grinding in a glacier.
- W ROOST: A place with perches for fowl or other birds or to rest or sleep on or as if on a perch or roost.
- F ROOT: Underground portion of a plant that absorbs moisture, obtains nutrients from the soil, and provides support.
- W RUT: An annually recurring condition or period of sexual excitement and reproductive activity in male deer.
- FE SAFETY ZONE: An area around a building that contains little fuel and is large enough to protect the building from wildland fire
- P SALISH: Salish Elders say that they, and many other tribes, were placed on this earth as one Salishan-speaking people. but they separated thousands of years ago into different bands. These individual bands then became separate tribes in different parts of the Northwest. eventually speaking different dialects of the Salish language. Their migration route extended from British Columbia to the present-day states of Washington, Idaho, MT and beyond.
- F SAPLING: A young tree.
- H SCAVENGER: An organism that feeds on garbage or dead animals.
- S SCIENCE: A process of investigation.
- W SEASON: One of the four natural divisions of the year, spring, summer, fall, and winter, in the North and South Temperate zones. Each season, beginning astronomically at an equinox or solstice, is characterized by specific meteorological or climatic conditions.
- E SEDIMENT: Particles of rocks.
- E SEDIMENTARY ROCK: Rock formed by tightly compacted sediments.
- F SEED: Offspring of a plant. Creates new plants.
- F SEEDLING: Young plant grown in a nursery, not yet 3 ft. tall.
- H SENSES: Touch, taste, hearing, smell, sight.
- FE SEROTINY: A property of tree cones, in which their scales are sealed by resin and they cannot release seeds until the resin is melted by heat.
- F SHRUB: Woody plant smaller than a tree, many small branches, no trunk; a bush.
- W SNOW METAMORPHISM: Changes that snow undergoes when pressure or other factors affect the crystals.
- W SNOW PACK: The accumulated depth of snow.
- W SNOW WATER EQUIVALENT (SWE) : The amount of water that would be obtained if the snowpack were melted, usually expressed in inches of water.
- F SOIL: The covering of the Earth's surface. Consists of rock particles and decayed organisms.
-

-
- W SOLAR INSOLATION: The amount of sunlight striking the earth's surface.
- H, F SPECIES: One kind of living thing; a group of organisms of the same kind that can mate and produce offspring like themselves.
- FE SPOT FIRE: A new fire that starts when burning material is carried by wind or conection ahead of an existing fire.
- F STEM: Part of the plant that holds leaves and flowers up and connects them to roots.
- E STRIATIONS: Scratches and grooves on bedrock surfaces, caused by grinding of rock against rock during movement of glacier ice.
- E STROMATOLITE: Calcareous fossil structure built by marine algae and having a round-ed form.
- H, F SUB-ALPINE: Transitional habitat zone between the valley floor and the alpine. Char-acterized by varying weather conditions dependant on elevation.
- W SUBNIVEAN: Area underneath the snow next to the ground.
- H, F SUCCESSION: 1) The process of change in a community. 2) The process of change in a community. After a severe fire, this is the way succession often works: Grasses and wildflowers may be the most obvious plants for a few years; then shrubs dominate, and finally trees. The first tree species to occur may be replaced by other species as succession continues.
- W SUPRANIVEAN: On top of the snow.
- FE SURFACE FIRE: A fire that burns in the litter, duff, grasses, and wildflowers on the for-est floor but does not burn in the crowns of trees.
- H TAME: An animal that has been brought from wildness into a domesticated state.
- E TECTONIC PLATES: Large slabs of rock covering Earth's crust that fit together like a puzzle.
- FE, W TEMPERATURE: Hotness or coldness of an object; Temperature is a measure of the average heat or thermal energy of the particles in a substance.
- S THEORY: An explanation or model that has been confirmed by experiments and obser-vations.
- FE THERMOCOUPLE: A tool used to measure temperature. A thermocouple is a junction of two metals whose voltage varies with temperature.
- FE THERMOMETER: A tool used to measure temperature.
- H THREATENED SPECIES: Species who will likely become endangered in the near fu-ture.
- H THREATENED: A species present in its range but in danger of becoming extinct.
- H, W TOLERATE: To put up with, or resist, an action;
- S TOOL: A device used to make a job easier.
- W TORPOR: A short-term condition physiologically similar to hibernation in which meta-bolic rate and body temperature may be reduced to conserve energy.
- W TRAILING: Following in tracks made by a strong lead animal.
- F TRANSPIRE: Give off water vapor through the surface (the body, or leaves).
- F TREE: A woody plant that, when fully grown, has a large central stem called a trunk.
- W TREE CAVITIES: Holes in trees that can be used by many organisms for shelter.
- F TREELINE: Elevation above which the climate is too harsh to allow trees to grow.
- W TREE WELL: The area around the base of a tree.
- H, F TUNDRA: Regions where it is very cold and there are almost no trees. This region has permafrost (soil that is at or below freezing for two or more years).
-

- W UNDER COAT: A covering of short hairs lying underneath the longer outer hairs of an animal's coat.
- F UNDERSTORY: Layer of plants growing under another higher layer of plants and brush under forest trees.
- E U-SHAPED VALLEY: Valley created by the weathering of glaciers.
- E VALLEY: An elongated lowland between ranges of mountains, hills, or other uplands, often having a river or stream running along the bottom.
- E V-SHAPED VALLEY: Valley created by the weathering of rivers and streams.
- E, W WATERSHED: 1) The region of land whose water flows into a specified body of water. The specified body of water can be of varying sizes. For example, you could refer to the Flathead River watershed or to the much larger, Pacific Ocean watershed. 2) An area of land that drains down slope to the lowest point. The water moves through a network of drainage pathways, both underground and on the surface.
- E WEATHERING: The breaking down, dissolving, and wearing away of rock.
- H WILD: Dependant on nature for survival- not tame nor domesticated.
- H WILDERNESS: See "wildland."
- FE WILDLAND FIRE: Any fire, other than prescribed fire, occurring in a wildland.
- FE WILDLAND: An area where the species present and the processes occurring are relatively unchanged from times before settlement by European Americans. Wildlands are often contrasted with agricultural and urban lands.
- W WIND CHILL: The temperature your body feels when the air temperature is combined with the wind speed.
- W WINTER: Usually coldest season of the year, occurring between autumn and spring, extending in the Northern Hemisphere from the winter solstice to the vernal equinox, and popularly considered to be constituted by December, January, and February.
- W WINTER COATS: Thicker pelage or fur, provides further cold protection (the winter coat of the mink is highly prized and is much thicker and heavier than the summer coat), as does the winter white fur of weasels and snowshoe hare. White hairs, without the pigment melanin, have more air spaces within the hairs and thus has greater insulation.

Resources & References

1. Abrahamson, Dean Edwin, *The Challenge of Global Warming*, Washington, D.C.: Island Press 1989.
 2. Alden, Peter (1987). *Peterson First Guides: Mammals*. Houghton Mifflin Company: Boston.
 3. Allison, Linda (1975). *The Reasons For Seasons*. Little, Brown and Company: California .
 4. Arthur Carhart National Wilderness Training Center. *The Wilderness & Land Ethic Curriculum*; 2nd edition.
 5. Beaumont, Greg (1978). *Many-Storied Mountains The Life of Glacier National Park*. Natural History Series, Division of Publications, National Park Service, Washington, DC.
 6. Brimmer, Larry Dane (2000). *A true Book: Mountains*. Grolier Publishing: New York.
 7. Bueking, Kris. *Living With Winter: An Integrated Curriculum Unit for Middle School Grades*; Montana Natural History Association: MT, www.montanaturalist.org
-

8. Burt, William (1976). A Field Guide to the Mammals. Houghton Mifflin Co.: Boston.
 9. Caduto, Michael J. (1988). Keepers of the Earth. Fulcrum, Inc.: NY, NY.
 10. Cornell, Joseph Bharat. Sharing Nature With Children. Dawn Publications, 1979.
 11. Cunningham, Carolyn Ed. (1983). Montana Weather. Montana Magazine, Inc.: Helena, MT.
 12. DeSairigne, Catherine (1986). Animals in Winter. Moonlight Publishing, Ltd.: New York.
 13. Gallant, Roy A. (1999). Glaciers. A First Book, Scholastic, Inc.: Danbury, CT.
 14. Gross, Phyllis and Esther P. Railton. Teaching Science in an Outdoor Environment. University of California Press, 1972.
 15. Harris, Jack, The Green house Effect, New Yourk: Crestwood House, 1990.
 16. Joy of Nature. The Reader's Digest Association, Inc.: New York.
 17. Kelly, David and Gary Braasch. Secrets of the Old Growth Forest. Gibbs Smith, 1988.
 18. Lingelbach, Jenepher (1986). Hands-On Nature: Information and Activities for Exploring the Environment with Children. Vermont Institute of Natural Science: Vermont.
 19. Lyman, Francesca, The Greenhouse Trap, Boston: Beacon Press, 1990.
 20. Lynn, Roger. "A Bear in its Lair." Natural History Magazine, American Museum of Natural History: New York, October 1981.
 21. Montana Natural History Center. "Montana Owls." The Montana Naturalist: Winter 2005-06, www.montanaturalist.org
 22. National Assessment Synthesis Team, Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, U.S. Global Change Research Program, 400 Virginia Ave., SW, Ste 750, Washington, D.C., 20024, www.usgcrp.gov
 23. NatureScope "Wild About Weather." National Wildlife Federation; Washington, DC; 1986.
 24. Nixon, K (1996). Animal Legends. Frederick Warne and Co. Inc.: New York.
 25. Parella, Deborah (1995). Project Seasons: Hands-on Activities for Discovering the Wonders of the World. Shelburne Farms: VT.
 26. Project Wild: "Visual Vocabulary", Boulder, CO: Western Regional Environmental Council, 1986.
 27. Shea, David (2000). Animal Tracks of Glacier National Park; Glacier Natural History Association: West Glacier, MT.
 28. Sheehan, Kathryn and Waidner, Mary (1991). Earth Child-Games, Stories, Activities, Experiments and Ideas About Living Lightly on Planet Earth. Council Oak Books: Tulsa, OK.
 29. Sisson, Edith (1982). Nature With Children of All Ages. Prentice-Hall, Inc.: New Jersey.
 30. Sloane, Eric (1963). Folklore of American Weather. Hawthorn Books: New York.
 31. The Earth Works Group, 50 Simple Things Kids Can Do to Save the Earth, New York: Andrews, and McMeel, 1990.
 32. Wood, Dorothy. Beavers. Chicago: Follett Publishing Company.
-

